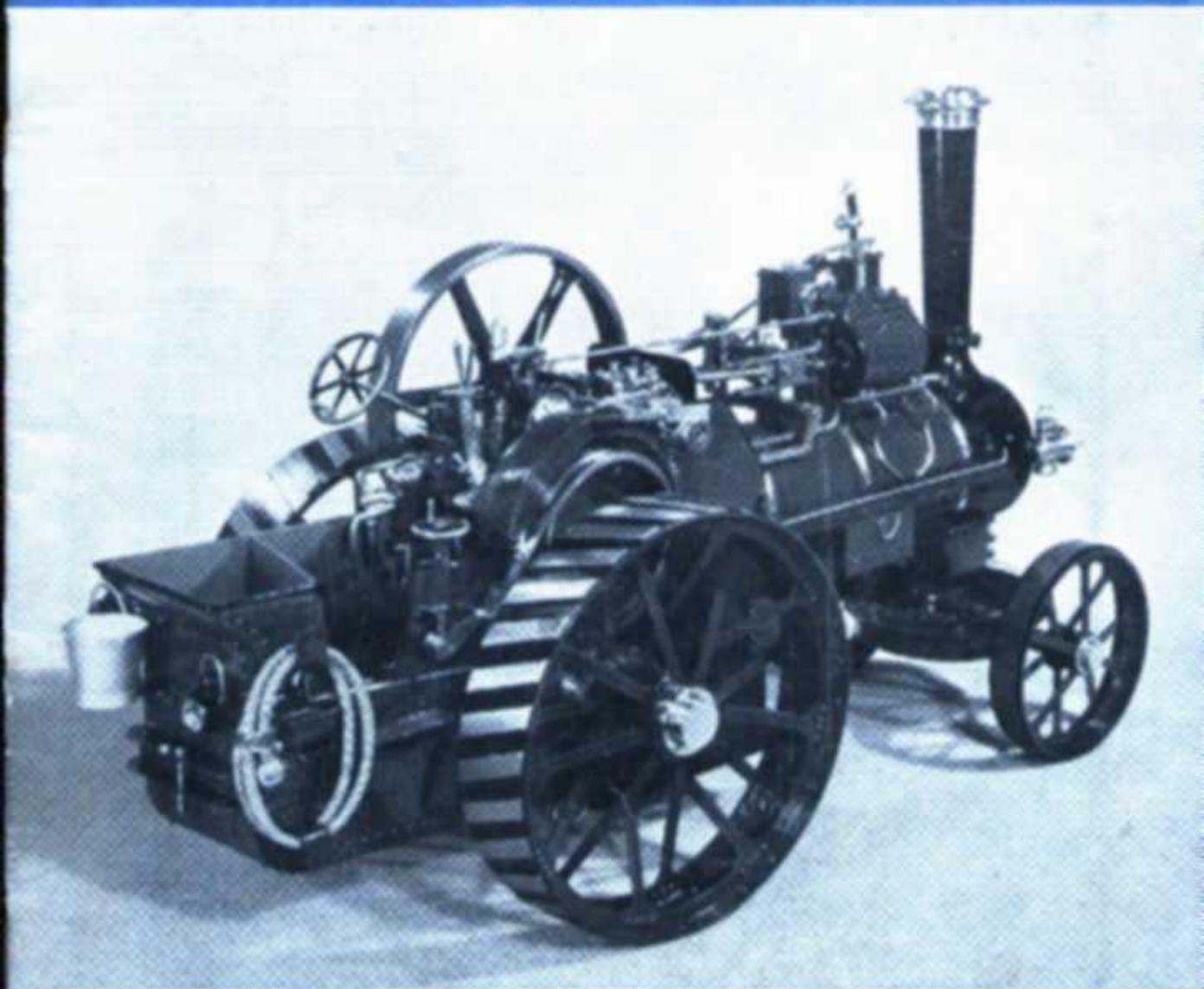
THE MODEL ENGINEER



IN THIS ISSUE

• THE PIONEER WORK OF DAIMLER • A TRAVELLING STEADY FOR THE LATHE • A NEW MILLING ATTACHMENT • L.B.S.C.'s TITFIELD THUNDERBOLT • READERS' LETTERS QUERIES AND REPLIES • BUILDING AN "ATLANTIC"

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THE MODEL ENGINEER

EVERY THURSDAY

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CONTENTS

SMOKE RINGS	365
BUILDING AN "ATLANTIC"	366
A 1½-in. SCALE BURRELL-TYPE TRACTION ENGINE	369
A TRAVELLING STEADY FOR THE LATHE	370
QUERIES AND REPLIES	372
DAIMLER—THE PIONEER	373
A BRITISH-BUILT DIESEL LOCOMOTIVE FOR THE COMMONWEALTH	375
A MILLING ATTACHMENT—"PLUS"	376
L.B.S.C.'s TITFIELD THUNDERBOLT IN 3½-in. and 5-in. GAUGES	381
MUSICAL MECHANISM The Reconstruction of an old Polyphon	384
THE NEW "GRANVILLE JUNIOR" 3½-in. LATHE	389
READERS' LETTERS	391
WITH THE CLUBS	393

Our Cover Picture

The 1½-in. scale traction engine seen on this week's cover is of more than ordinary interest. It was built by Mr. W. C. Higgs, whose story, with another picture, will be found elsewhere in this issue. The chief points to notice are that it is based on a commercial design and that the construction was successfully completed without any elaborate workshop equipment; in other words, enthusiasm, determination, and the conscious or unconscious thought that what one man can do another can, won the day. The result is a nicely-proportioned engine and one of which it would be difficult to decide just what details are missing, or unsightly. It has stood up well to the severest test, i.e., being photographed; it is not strictly "Burrell," yet it is anything but a monstrosity!

SMOKE RINGS

The Lion and the Mouse

WHILE THE subject matter of THE MODEL ENGINEER is intended to appeal mainly to the amateur craftsman, its scope is by no means restricted to this exclusive sphere, and many professional engineers have at various times paid a tribute to the helpfulness and practical soundness of the information found in our pages. There are few subjects in engineering which have not been dealt with at some time or other in THE MODEL ENGINEER, and copies of it are not infrequently seen in industrial drawing offices—even, at times on the works managers' desk.

On many occasions we have been approached by manufacturing firms and Government departments for advice or assistance in some problem which is outside the scope of the standard text-books or other orthodox sources of technical data. There have, of course, been occasions when we have had to admit that problems of a specialised nature are outside our experience, but generally speaking, we have been able to help, either by furnishing information directly, or by referring enquirers to reliable sources of information. The subjects which have been successfully dealt with in this way range from the design of delicate mechanical and electrical apparatus, machine tools, manufacturing processes and methods, to civil engineering in many of its varied forms.

Readers will remember Aesop's story of the mouse who was able to help the lion out of a very serious difficulty; in the same way, THE MODEL ENGINEER is always able, and willing, to exert all its efforts to help either the amateur or professional engineer in any of the technical problems which he many encounter.

Romford "Club News"

WE HAVE received a copy of a new bulletin that is helping to swell the number of privately-produced "house magazines" by model engineering clubs; it is a cyclostyled magazine of eight pages in a paper cover, and is issued to members of the Romford Model Engineering Club. The Joint Editors are J. F. Bruton and F. E. Chapman, who have certainly produced a bright, readable magazine of just the right character.

National Traction Engine Rally

THE SECRETARY of the National Traction Engine and Tractor Association Incorporated has announced that a National Traction Engine Rally will be held at Bridge Farm, Appleford, near Abingdon, Berks., on Saturday, June 12th next. It will be open to the general public from 2.30 p.m., but for the benefit of those enthusiasts who would like a closer look at the engines taking part, and perhaps to take photographs as well, admission to the Rally will be possible from 10.30 a.m. For this purpose, a special admission ticket will be available at a nominal charge. Further information and entry-forms may be obtained from the Secretary M.T.E. & T.A. Duke Street Chambers, Duke Street, Reading, Berks.

The Kodak Exhibition, 1954

EVERY TWO years, Kodak Hall, in the Social Centre, Headstone Drive, Wealdstone, is the venue of the exhibition that has thoroughly established itself as one of the highlights of our hobby. Although it covers every kind of handicraft, the model engineering section is always very strong, due to the open invitation extended by the Kodak Society of Experimental Engineers and Craftsmen to all kindred societies within reach.

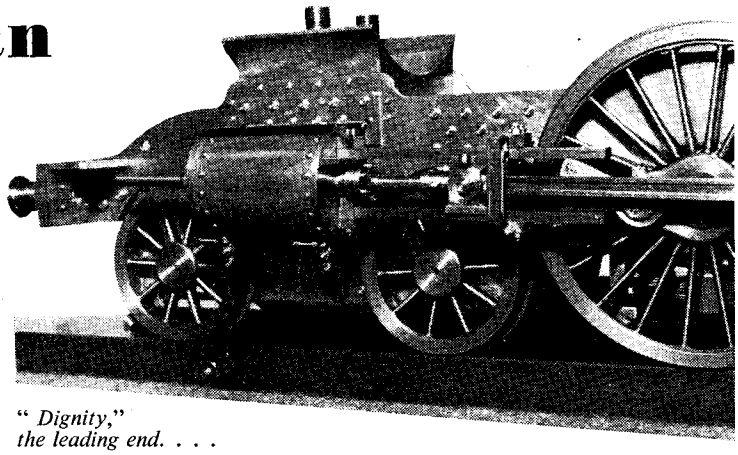
This year, the exhibition will be open from 2 p.m. till 10 p.m. on Saturday, May 15th, and from 2 p.m. till 9 p.m. on Sunday, May 16th.

Clubs and societies wishing to co-operate are cordially invited to communicate with Mr. F. Day, K.S.E.E.C. Exhibition Organiser, K.R.S. Office, Kodak Limited, Wealdstone, Middlesex.

The charge for public admission to the exhibition will be 1s.; children 6d.

Building an "Atlantic"

By E. Brown



"Dignity," the leading end. . . .

THIS ¾-in. scale model is being built with one particular aim, and that is to recapture in miniature the beauty of the G.N. large Atlantics as they were in their heyday, as they were in L.N.E.R. days—remember the sight and sound of those grand old engines pounding up Stoke bank with the West Riding "Pullman," or recall the great feats of engines like No. 4404 taking over from Pacifics and keeping time, yes even gaining time. It was indeed a sad day when No. 62822 ran her last trip to Doncaster; however, we still have No. 251 to gladden the eye, but isn't it a pity that she has had her superheater removed? With the chimney position set back the appearance of purposefulness is to a great degree destroyed, along with her efficiency.

However, from pleasant memories to practical details. I will now endeavour to give a brief description of the construction of this little engine so far, which I hope will be of interest to many who worship at the shrine of the steam locomotive and in particular those admirers of the "green 'uns."

To begin with, I must say that, strictly speaking, this model is semi-scale only, and I think most readers will agree that it would be wellnigh impossible to build a dead scale *working* model of this class.

The main and trailing frames are cut from 3/32-in. steel plate and the frame stretchers are machined from steel also. The main frame plates are carried right through to the trailing drag beam. The front buffer beam and the drag beam are made from bright mild-steel angle and are secured to the frames by the same method as described by "L.B.S.C," as I consider that for strength this method takes some beating.

The main frames on the big engine were "cranked in" just ahead of the leading coupled axle to give more room for side movement of the bogie truck. On the model, however, I considered this cranking of the main frames too risky, also I wanted to be able to run on a minimum radius of 30 ft. at least, so the frames were cut away over the bogie wheels. I am hoping that when the deep valance is fitted to the leading running-plate and the splasher is fitted over the trailing bogie wheel this cutting of the main frames will not be noticeable. Except, perhaps, by J.N.M. !

Castings for the cylinders were run off in phos.-bronze by a local foundry from my own pattern; this foundry also cast the smokebox saddle. The cylinders are scale bore and stroke, i.e., 1¼ in. × 1½ in., and the pistons are packed as described by "L.B.S.C." The piston-rod ends are coned for the pistons.

The arrangement of the cylinders and piston valve steam-chests presented somewhat of a problem, but it was finally decided to cut two rectangular slots in each main frame, these slots to be at 90 deg. to the inclined centre-line of the cylinders and each cylinder and steam-chest to have spigots machined on their bolting faces to register with the slots. By this method the aligning of both units is achieved automatically, the load on the cylinder bolts is considerably reduced and the main frame is not unduly weakened. The steam passages between cylinders and steam-chests are in the centre of the spigots and the jointing facing are scraped in "face to face."

The cylinders on the prototype had the back cover cast integral with the barrel. On the model the back cylinder covers are fitted with csk. screws and a cloaking cap made to fit over the cylinder cover proper; this cloak has a dummy rib fastened to it as will be seen on the photograph. The piston glands similarly have the normal type of screw gland mocked up to represent the full-size gland cover which was a "six studder," to quote a running shed term.

The typical large cylinder bolting flange with its conspicuous double row of bolts adds considerably to the realism I think. An old friend of mine who served his time at Doncaster in Great Northern days can relate how those cylinder bolts were in fact studs and nuts, the order was that the stud ends should be knobbled over, filed and polished to look like bolt heads; the hexagon of each "head" had to be screwed up until all the heads were lying the same way; e.g. a flat facing uppermost. Those were the days !

The cylinder cocks fitted to the earlier types of piston valve Atlantics had a cast bib end, later another pattern was introduced with the copper pipe and union nut. The former type was chosen for the model as it was considered easier to produce a nearer scale working unit with a fabricated body. The relief valves have a 3/32 in. diameter cone valve. Although the final products are over-scale I do not think that they spoil the appearance too much.

A five pint blowlamp was used to fabricate the steam-chests which are made up of drawn brass and silver-soldered. The piston-valve liner is in chill-cast phos.-bronze and the bobbins are made and fitted generally to "L.B.S.C.'s" recommendations. The valves are ⅝ in. diameter, inside admission, the bobbins were kept as wide apart as possible to reduce the length of steam passages which are, by the way, the same size as the ports right through to the cylinder. The ports are ¾ in. × ⅛ in., the valve travel 9/16 in. and the lap ⅛ in. The eccentrics are set to give line to line admission to steam in full gear.

The valve spindles pass right

through the valves and work in the dummy gland covers at the front of the chests. These dummy gland covers and the back steam-chest covers are made to represent those of the big engine; they are of necessity overscale, but I feel they do give an atmosphere of Ivatt, Gresley and Doncaster.

The exhaust manifolds from each steam-chest are fabricated from square brass tube, the inside cross sectional area of which is a little less than twice the area of the steam ports. All the bends have been swept to the easiest possible radius in the limited space available.

As regards the valve-gear—I'm afraid I have committed an unforgiveable offence, as this resembles very closely the Stephenson's link motion fitted to the " Jersey Lillies " (the Great Central Atlantics). Readers who know of the animosity that existed between the G.C. and the G.N. will appreciate the risks I have taken !

The design of the gear is based on a series of articles published in THE MODEL ENGINEER, Vol. 77 by G. S. Willoughby. Launch-type links are arranged ahead of the leading axle and the die-blocks work in forked ends of the valve spindle guides. A simple model was made to determine the best position for the link suspension. The eccentric sheaves have the usual irregular shaped holes cut into them to reduce the out of centre weight, and the eccentric straps are of steel with phos.-bronze liners. The eccentric-rod ends are flanged and secured to the straps by studs and nuts. All motion pins are held in position by collars and taper pins.

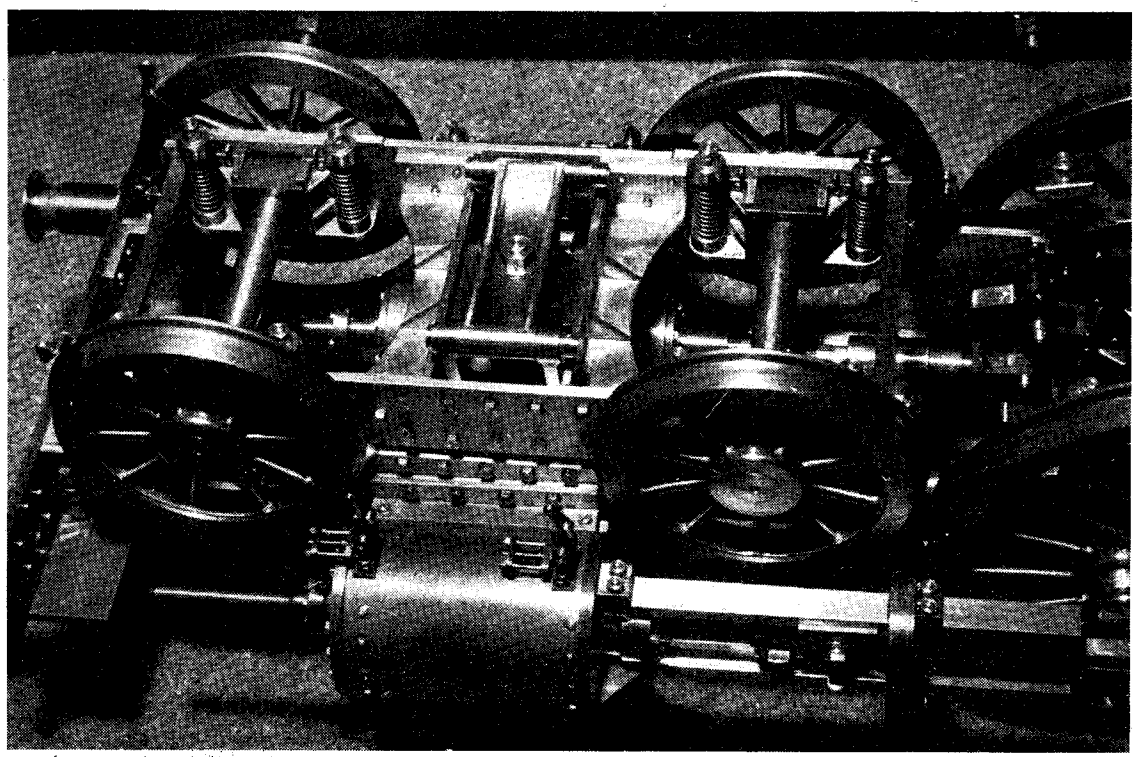
The crossheads are made similar to " L.B.S.C.'s " method, i.e., the gudgeon-pin having a large head, thereby allowing the little end pocket to be machined comfortably with a boring tool. Although the piston-rods are secured to the crossheads by working cotters the piston-rod ends are parallel and make a neat fit in the crosshead boss. This method is used on the full size valve spindle crossheads of the Walschaerts gear fitted to the Gresley 3-cylinder engines. The profile of the crosshead was sketched from engine No. 62822 while she stood in Grantham station.

The connecting-rods are dead scale on the side elevation but overscale in thickness and are fluted on the front only. Split big-end brasses and working cotters are fitted, but the big-end bolt is parallel. The driving crankpins are not turned eccentric as on the prototype (Mr. Ivatt's idea to give the connecting-rod a larger throw than the coupling-rod) as this feature was not considered to be worth the extra trouble involved.

The slide bar brackets are built up from steel and resemble the full-size article reasonably well.

Coupling-rods again are scale on the side elevation and overscale in thickness. An interesting feature about the big engines coupling-rods was the depth of the flute—$\frac{1}{4}$ in.—and on the front only. Surely fluted for sake of appearance only !

The coupled wheels were cast by Stuart Turner Ltd. from my own pattern and a very fine job they were too. Upon looking at my drawing I had grave doubts about the uneven contraction due to the very large wheel boss; however, Messrs. S.T. Ltd. mastered the situation. The pattern was made with draw from the front face only so the spokes had to be filed oval on all wheels after machining—some job, but worth it. The balance weights were fitted



Mainly Doncaster, but a trace of Gorton

separately and are of steel. Those familiar with the full size engines will recall that facing on the crank boss which was machined to clear the side rod oil-cup—this facing reminded one of the moon in partial eclipse—and on the model the effect is most pleasing. Should any reader care to look up THE MODEL ENGINEER for June 17th, 1948, he (or she) will find an excellent drawing of No. 4444 by F. C. Hambleton, the facings previously mentioned are clearly visible. I would like to say that I consider this drawing to be the finest of an L.N.E.R. "C.1." that has been published.

A jig was schemed out to facilitate quartering the coupled wheels.

The leading side rod caps have the three hex. head set-screws with their heads sunk in below the front face of the cap as on the prototype. These set-screws have 12 B.A. threads and hexagons $\frac{1}{16}$ in. across the flats. Screws of the same size are used for the big-end cotter set-screws.

The main axlebox horncheeks were shaped from stock castings supplied by Kennion Bros. The ribs and outside shape were altered to suit my drawing and additional ribs and oilboxes added. I have not fitted any axlebox wedges. The axleboxes themselves have separate keeps and close inspection of the photographs may show the hornstays which embrace the horns as per usual full-size practice.

The driving axle is fitted with coil springs and the leading axle with leaf springs. Phos.-bronze spring strip of 20-gauge is used for the plates of the leaf springs, and between each plate there is a 0.005 in. spacing shim hidden inside the buckle, this idea was, I believe, used by Brunel on his engines for the old G.W. broad-gauge, to allow the springs to flex more easily. I have also drilled a considerable amount of metal away from the centre of the leaves to give more resilience. The Spencers auxiliary springs (shock absorbers) at the bottom of the spring hangers have blocks of neoprene rubber fitted. Although this leaf spring assembly is not truly to scale I do feel that it has been well worth the trouble, if only for the sake of added realism. I also hope to get a steadying effect from these springs when the engine is doing a scale 95 m.p.h. ! Did I hear someone say: "You'll be lucky, with steam passages of that size."

While on the subject of leaf springs I might mention the trailing carrying springs. These are also made of 20-gauge phos.-bronze, and have the correct number of leaves and are scale width, 0.005 in. shims are again fitted inside the buckles and I intend to drill weakening holes in these leaves also. But due to the wider spacing of the hanger brackets allowing longer leaves they are reasonably lively at present. The Spencers auxiliary springs fitted to these hangers also have neoprene rubber blocks. The spring hanger brackets were machined with a spigot to take the load off the three scale rivets which secure them to the trailing frames. Steel was again used to fabricate the trailing horns which are fastened to the frames by scale size steel rivets at scale spacing. The hornstays are of correct pattern and slot into the frames. The baby oil-box on the front of the trailing axlebox has a hinged lid.

It was decided to try and wangle a swing-link bogie for this engine, as she would not be an L.N.E.R. —G.N. section—engine without one. But I wanted to negotiate curves which would be grossly overscale, so, after some deliberation I drew out a swing-link arrangement, more like that of the A3 Pacifics, with longer links pivoted higher than on the "C.1." Atlantics. I arranged the angle of the links to allow the engine to take a 26 ft. minimum radius curve without "falling over." I have since made up a short length of track to this radius and the swing-links cause the bogie chassis to tilt in a most effective manner.

Messrs. Kennion Bros. had the bogie and trailing wheels cast for me; fortunately, I only had to make one pattern for these as on the full size engine they were all 3 ft. 8 in. diameter. As on the coupled wheels the spokes are all filed to an oval section.

There is one small feature that I consider very often spoils the appearance of a miniature bogie and that is the diameter of the axle that shows on the face of the wheel boss. Invariably in full-size practice the diameter of the axle which is fitted into the wheel is *larger* than the diameter on the journal. On the model the axles are turned down either end in the normal way, the wheels pressed on and then run between centres while the axle end is skimmed flush with the wheel boss; then with a knife tool a light cut is taken across the boss towards the centre until a dummy axle end of the scale diameter is obtained.

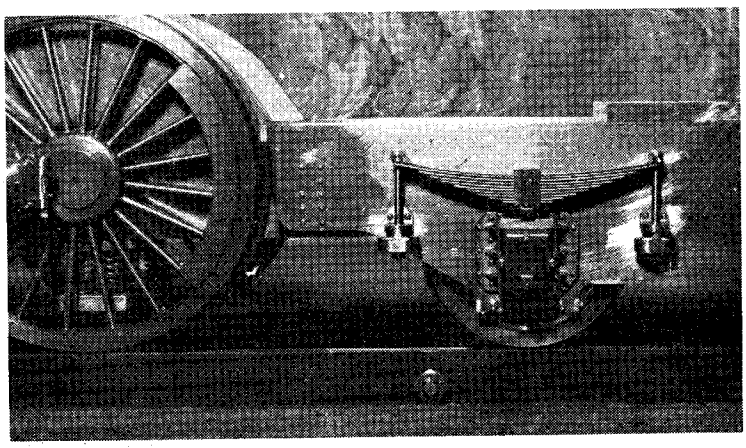
The wheels are the only castings used on the bogie, the frame stretchers and axlebox horns are fabricated from steel and the axleboxes, centre-slide block, etc., are machined from the solid. The boxes are fitted with keeps and the hornstays embrace the frames. I think that out of all the parts that go to make up the bogie truck the worst job was making and fitting the railguards, or perhaps tapping the 14-B.A. stud holes for the leading axlebox splash plates.

All the lathe work, except for the segment of steel for the die-blocks, has been carried out on a Myford $3\frac{1}{8}$-in. lathe (£7 before the war), ably assisted by a Champion No. 1 sensitive drilling machine, and, more recently by a Super Adept hand-shaper. The milling operations were done with home-made cutters.

This engine is a model of No. 4433 as she was in the middle 1930's.

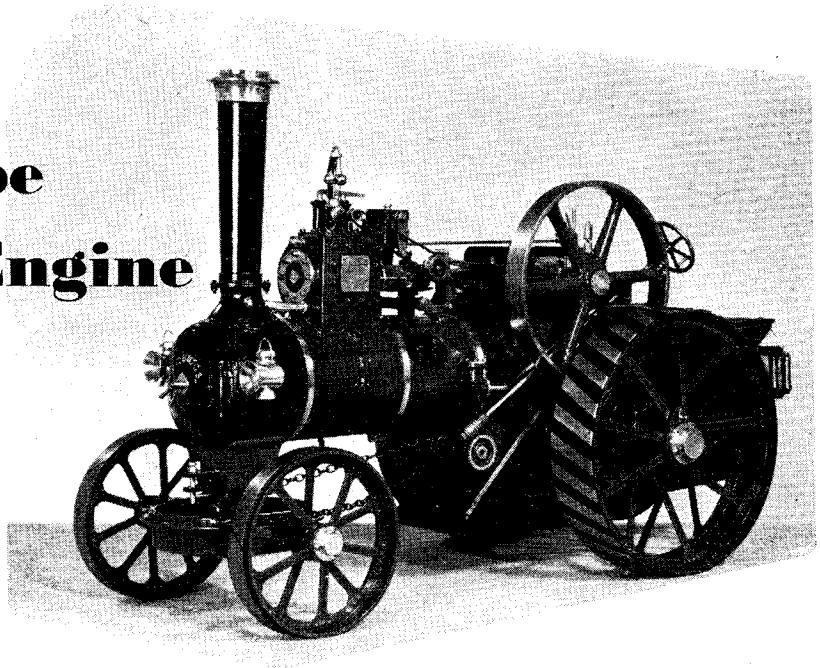
The photograph illustrating this description are the work of D. A. Dean, M.P.S.

Acknowledgments must be made to British Railways E. & N.E. Region for the help they have given in the search for accurate information of the prototype.



. . . and the trailing end with its leaf-spring

A 1½-in. scale Burrell-type Traction Engine



By W. C. Higgs

IN August, 1952, after many years of admiring traction engines and with very limited workshop equipment, a start was somewhat dubiously made on the construction of a 1½-in. scale Burrell traction engine to the designs prepared by a firm of well-known model engineers (Bassett-Lowke).

As a result of such beginnings some two and a half years later a coal-fired Burrell "type" of traction engine has evolved; the word "type" being used advisedly as in pandering to personal likes and dislikes many deviations have been made and "non-standard" items introduced, which ignored the purchased drawings and necessitated the preparation of numerous alternative sketches.

At the commencement the workshop equipment consisted of a 2½ in. Haighton screw-cutting lathe, ¼-in. drilling machine, compressor, grinding head, wire wheels, buffs, etc., ½-in. portable electric drill, and a varied assortment of hand-tools, and brazing gear. From this, the first problem was the turning of the rear wheel rims and two other items beyond the capabilities of the little Haighton lathe, and here thanks are due to friends who, with larger equipment, came to the rescue. Gear cutting again proved to be beyond the limited resources of the home workshop and on the prepared blanks assistance had to be sought. Other than these items, the remainder of the work has been carried out on the equipment referred to and much use made of saw and file.

One boiler was made but did not come up to standard and reluctantly had to be scrapped. The second was modified in design and proved to be successful. The hydraulic test pressure was satisfactorily held at 140 lb. per sq. in. The smokebox, chimney and front wheels were a straightforward job, commercial castings forming the basis of same.

The motion work proved interesting, and presented no undue problems, but the cylinder block was another question altogether. After much thought and many sketches it was decided that the whole of this should be built up, and eventually so it was, no castings being used whatsoever. Whilst this was a fairly long job, results have shown that it is perfectly successful, and it has never given any subsequent trouble. A mechanical lubricator was made, but under steaming conditions proved to be a persistent nuisance until really steam-tight non-return valves were made, a task which was easier said than done.

Steam trials were made and, other than the lubricator, all went well although minor adjustments were made, and as time went by, odd items were modified and "frills" added. At all times the unit has produced a sufficiency of steam which led to light blowing-off even under heavy load. The feed pump was modified and re-built during tests in order to deliver a little more water and make a better use of the by-pass, as it was found that full bore of the pump only just maintained water level when under load.

On the completion of the model from the point of view of satisfactory operation and the adding of odd items, such as lamps, winch rope, bucket, etc., etc., it was painted emerald green and lined in red and black.

In order to carry out this last mentioned section of the work, it was, of course, necessary to dismantle the model, and here the opportunity was taken of doing this very thoroughly, so that a complete investigation could be made of all the working parts and their condition after the work that had been done. It was very satisfactory to discover that no undue and not much detectable wear had taken place in any of the components.

Since the painting has been completed the model has not been in steam, but for the future it is intended that it shall be used and not become merely an ornament, and one day it is hoped to produce a suitably designed trailer to enable the driver to ride in comfort instead of balancing on a piece of board and three wheels.

A résumé of further information relating to the model is as follows:

Time to construct and operate—approximately 1,450 hours over two and a half years.

Model in steam approximately 85 hours. Blow-off pressure 65 lb. per sq. in.

Approximate over-all dimensions 24 in. long × 10 in. wide × 15 in. high.

Bore $\frac{15}{16}$ in. diameter × $1\frac{1}{8}$ in. stroke.

Engine hauls maker without difficulty.

Photographs by Studio Camm—Wilmslow.

A TRAVELLING STEADY FOR THE LATHE

"By Duplex"

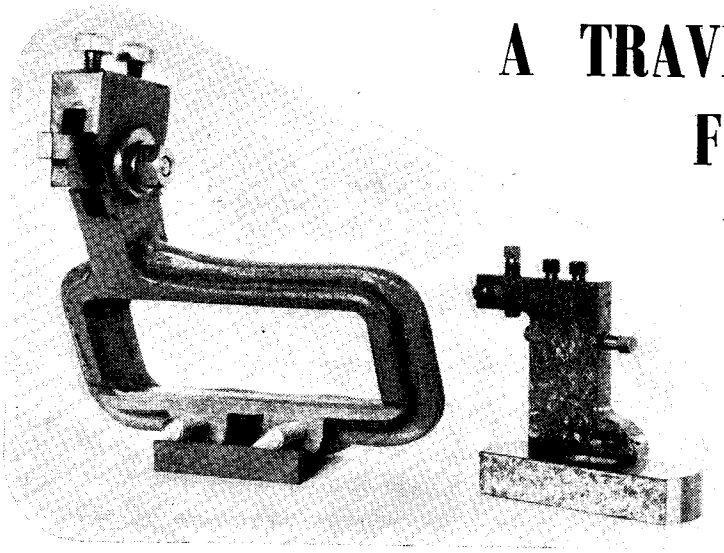


Fig. 1. *The small travelling steady and the attachment it replaces*

SOME users of the popular 3½-in. Drummond lathe will, no doubt, consider the travelling steady, as originally made, a rather clumsy contrivance, for it consists of a heavy iron casting, which is bolted on to the back of the saddle casting and has an opening in the base large enough to allow the cross-slide to pass through. In fact, we have received requests from readers for an alternative design to enable a simple form of attachment to be made in the workshop.

The conventional point of attachment for a travelling steady is, of course, to the saddle casting, for the steady is then guided directly from the lathe bed sheers, and the position of the vertical pressure-finger remains always in line with the lathe axis.

But when the steady is attached to the cross-slide, any slackness in the feedscrew of this slide will allow the steady to move in a direction across the lathe axis. However, this difficulty can be overcome by locking the cross-slide while taking a traversing cut. In any case, whether the steady is attached either to the saddle or to the cross-slide, the pressure-fingers will have to be readjusted each time the diameter of the work is reduced in the course of a machining operation.

In the present design, where the steady is attached to the cross-slide, provision is made for maintaining the vertical pressure-finger directly in line with the lathe axis.

One advantage of mounting the steady in this position is that, by bolting the attachment to one of the cross-slide T-slots, the steady can be moved, as required, to correspond to any particular setting of the tool, whether this be towards or away from the lathe headstock. In this way, machining with the tailstock barrel almost fully extended can usually be avoided.

Making the Steady

The steady illustrated is built up from two main parts; that is to say, the base mounting and the upright carrying the pressure-fingers. It is as well to make these components really robust, so that the finished fitting is fully rigid. The base is clamped to the cross-slide by means of a single ⅜ in. diameter T-bolt, and this has been found in practice to give a secure hold, for there is hardly any turning moment on the bolt itself. The base is also slotted to provide the range of adjustment necessary to keep the steady in step with movements of the cross-slide. After being filed or machined, the

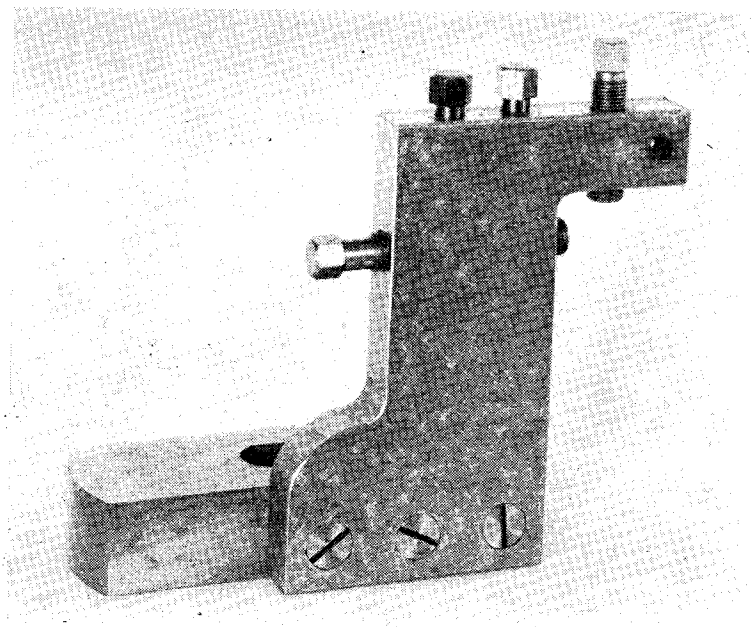


Fig. 2. *The finished steady*

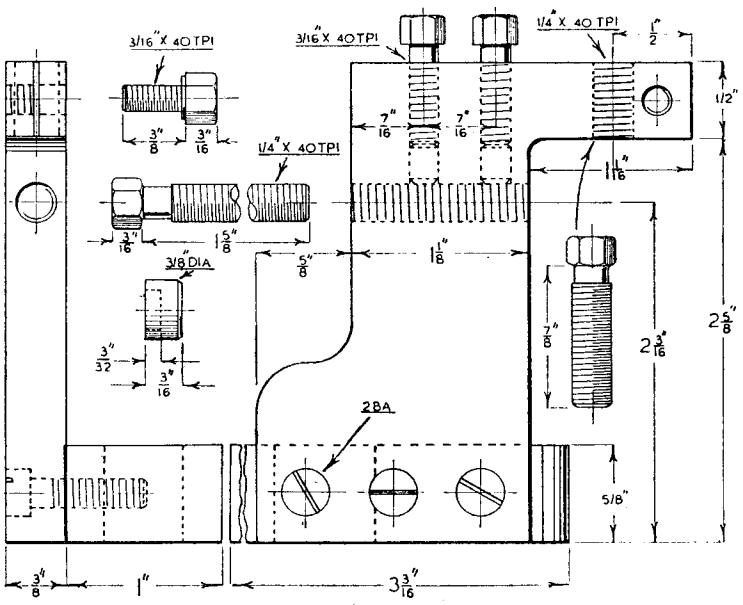


Fig. 3. Deatils of the two main components and the pressure screws

underside of the base should be scraped true, in order to provide a flat seating. The upright is cut to shape from $\frac{3}{8}$-in. mild-steel, and is secured to the base with three 2-B.A. cheese-head or Allen cap-screws. Care should be taken to ensure that the bolting faces are made truly flat.

The Contact Screws

These pressure-fingers are made of silver-steel, and are threaded 40 t.p.i. for ease of adjustment. It will be seen that all the screws fitted have 4-B.A. hexagon heads, so that a single box-spanner can be used for making all necessary adjustments. The contact surfaces of the screws should be turned to a smooth finish, and afterwards polished, in order to avoid scoring the work; the screws are finally hardened right out by quenching in thin oil. The centre-line of the horizontal pressure-screw is set $2\frac{3}{16}$ in. above the underside of the base, to correspond to the lathe centre height above the upper surface of the cross-slide. After it has been adjusted, this screw is locked by the two $\frac{3}{16}$ in. clamping-screws fitted with brass pressure pads. When the vertical pressure-screw is retracted, work of a diameter up to $\frac{3}{4}$ in. can be accommodated in the steady for taking the first cut. The capacity of the attachment was limited to this figure for the sake of compactness; moreover, larger work will hardly need a steady, as only comparatively short, 16 in. lengths of material can be mounted between centres in the standard lathe. The vertical pressure-screw is secured by means of a single clamping-screw, closing the slit-end of the upright member. Plain-ended pressure-screws have been fitted, although in production work rollers are often used.

The objection to roller steadies is that, unless a copious stream of cutting fluid is applied under pressure to the work, to wash away the swarf, chips are liable to collect between the rollers and the work and upset the accuracy of the machining. However, the smooth contact surfaces of the plain screws should have little more than a burnishing effect on the work; but where, as in screwcutting, it is important to avoid any possibility of damaging the work surface, the screws can be fitted with small bronze caps of the form shown in the drawing. These caps are made a clearance fit on the tips of the screws, and should not be threaded.

Using the Steady

As the steady must be started on a true-running surface formed on the work, the end of the part adjacent to the back centre should first of all be machined parallel for a short distance, bearing in mind that the steady is usually set so that it travels immediately in the wake of the tool. If the steady leads the tool and the unmachined work surface is irregular, inaccurate machining or worse will result.

As previously mentioned, the horizontal pressure-screw is located at lathe centre height, but the vertical screw will move across the lathe axis in following the movements of the cross-slide.

However, the contact face at the end of the latter screw is 7/32 in. in diameter, and this allows for feeding the cross-slide inwards for a short distance before resetting the position of the base of the steady becomes necessary. For example, if in the first instance the vertical screw is set slightly off-centre on the work, a shaft can be reduced from $\frac{3}{4}$ in. to $\frac{1}{2}$ in. in diameter without altering the position of the steady.

With the tool adjusted for taking a traversing cut, the base of the steady is clamped so as to bring the centre of the vertical screw a little towards the operator, and both screws are then set to bear lightly on the turned portion of the work. The pressure-screws, as well as the lathe cross-slide and top-slide, are then securely locked. When taking the second cut along the work, both pressure-screws must be re-adjusted, but the position of the base of the steady will not need to be altered until the diameter of the work has been reduced by some $\frac{1}{4}$ in.

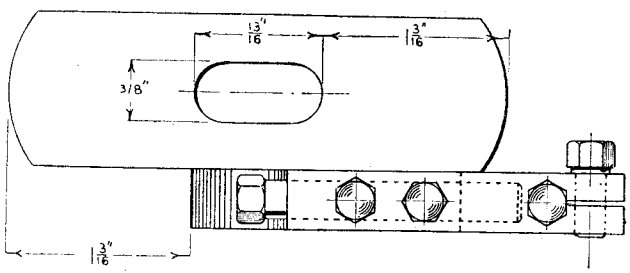


Fig. 4. Plan view, showing dimensions of the base

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Centrifugal Clutch

Have you any drawings of a centrifugal clutch suitable for a 30 *c.c.* 2*-stroke engine which runs anticlockwise, shaft size* $\frac{3}{8}$ *in. If you have a drawing, please state cost, and if possible the likeliest place to obtain materials for same.*

W.C. (Leysdown, Isle of Sheppy).

We regret that we have no separate drawings of this type of clutch, but in the detail drawings of the "1831" locomotive, particulars are given of a clutch which would be suitable for an engine of this size. A general arrangement drawing of this clutch is reproduced here.

The clutch can be adapted for either direction of rotation by suitable arrangement of the components. The main components of this clutch are intended to be made from castings, but we cannot advise you where such castings can be obtained. Alternatively, it could be machined from solid gunmetal or light alloy.

Air Compressor Lubrication

I have obtained a compressor of 2*-in. bore* × 2*-in. stroke but am having trouble with the lubrication. Could you please give me any information as to the most suitable oil for lubricating air compressors? Also, please advise me whether a* $\frac{1}{2}$*-h.p. electric motor is big enough to drive this compressor, as the one I am using appears to be making rather hard work of it.*

J.H.W. (Fakenham).

We cannot advise you as to the most suitable lubrication, unless we have full information with regard to the design of the particular compressor.

Some types of compressors have sump lubrication, while others have a drip feed or other method of feeding oil at a definite rate. Generally speaking, most compressors will work quite well on ordinary grades of motor lubricating oil.

We are of the opinion that a $\frac{1}{2}$-h.p. electric motor should be capable of running the compressor at a speed of about 750 r.p.m. with an output pressure not exceeding 50 lb. Incidentally, we may mention that a single-cylinder compressor must always have a fairly heavy flywheel, as this will help to avoid abnormal momentary load on the compression stroke.

Model Cars

Would you please give me some information on the following points regarding model car building.

(1) *Can I use diesel oil in the engine in place of petrol?*

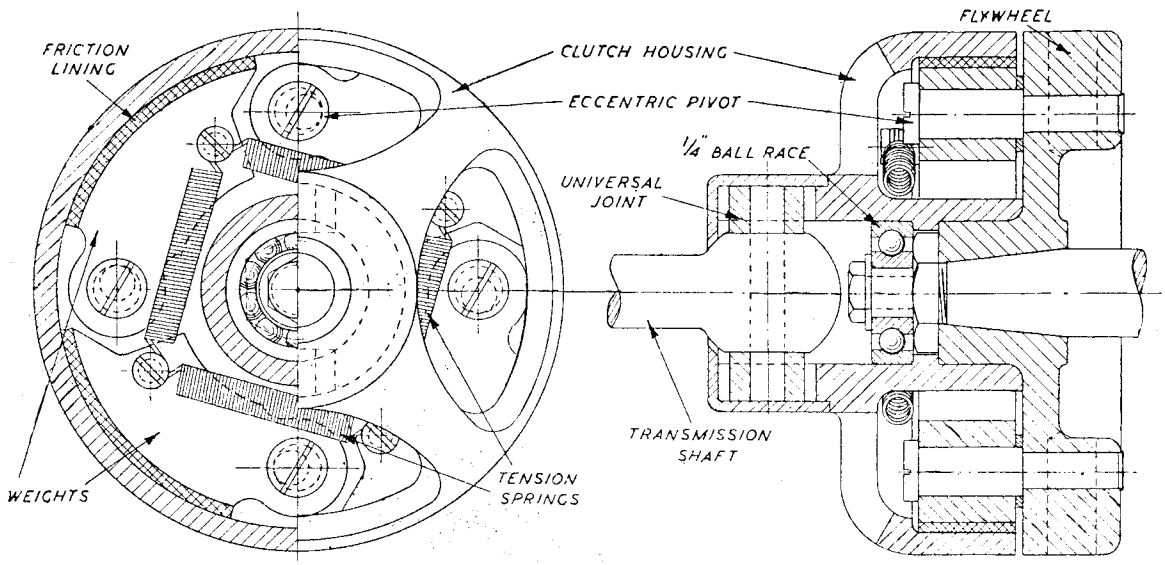
(2) *Is there any specified weight, size or wheelbase for* 1 *c.c. to* 5 *c.c. and* 9 *c.c. engines?*

I.T. (Blaby).

(1) No small engines of a size suitable for this purpose use ordinary diesel oil so far as we are aware. The so-called diesel or compression-ignition engine as made in small sizes uses a compounded fuel, usually containing a certain proportion of ether, which enables it to ignite at relatively low temperature.

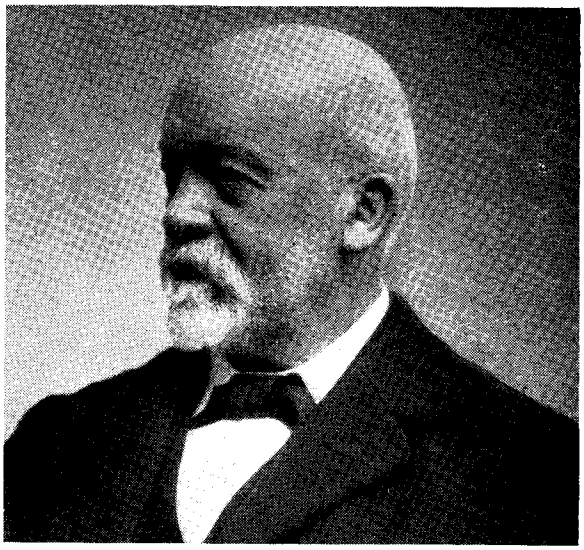
Other engines use glow-plug ignition, in which case a fuel usually containing alcohol is employed. Spark ignition engines will run on plain petrol, though in this case also, compounded fuels are often employed.

(2) For the specifications of model racing cars of various classes, we advise you to apply to the Model Car Association and the secretary is Mr. I. W. Moore, 2, Bridge Street, Derby.



Daimler —the Pioneer

By St. John C. Nixon



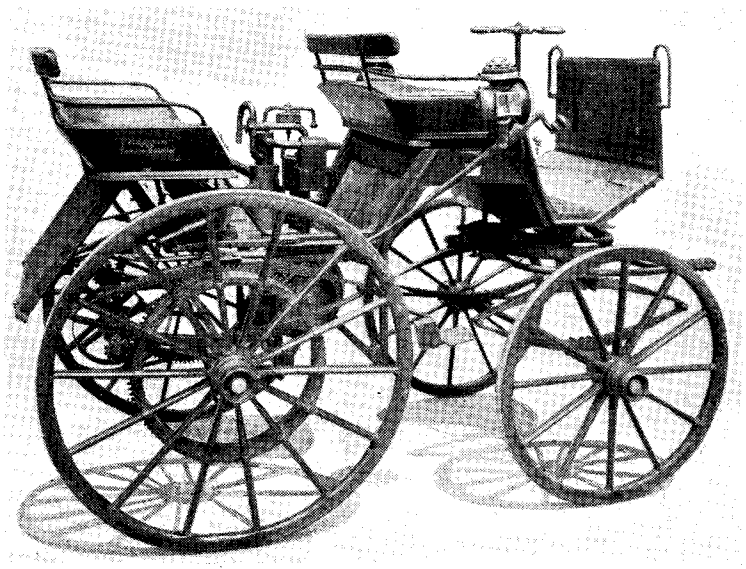
Gottlieb Wilhelm Daimler, inventor of the first fast-running internal combustion engine

PRECISELY who invented the petrol-driven motor vehicle is a question which will probably be debated for ever, as the correct answer turns entirely on the interpretation given to the word "inventor." A number of courageous and ingenious engineers experimented long before the first successful motor-car saw the light of day, but nothing came of these experiments, and if none of these engineers had ever been born, the development of the motor-car would not have been retarded by a single iota.

The two men who finally solved the problem, and from whose efforts automobilism of the world began, were Karl Benz—the son of an engine-driver and the grandson of a blacksmith—and Gottlieb Daimler. Let us take a glance at the life-work of the latter, and at a later date, no doubt it will be possible to describe the pioneer work of the former.

Early Promise

Gottlieb Daimler, the son of a master-baker in Germany, was born on March 17th, 1834. He served his early apprenticeship with a gun-maker in his native town of Schorndorf, and his skill became apparent while he was still a boy, when he made a pair of pistols with butts very finely chased, to his own design. After holding a number of positions in the engineering world, including one at Sir Joseph Whitworth's works in Coventry and Birmingham, he returned to Germany and was appointed technical director of Otto and Langen, gas-engine manufacturers of Deutz. After playing an important role in the development of the early gas engine, he went to Russia to study oil-conditions in that country, and finally, he purchased a large house in the Taubenheimstrasse in Cannstatt, built an extensive workshop, equipped it with the necessary tools and began experimental work on internal-combustion engines and on road-vehicles, and boats.



The first four-wheel motor vehicle of 1886 *by Daimler. It was, in fact a horse-drawn carriage with the shafts removed and a steering gear installed. The single-cylinder* 1½ *h.p. engine was vertical, with tube ignition, and the car had a maximum speed of* 18 *kilometres per hour*

Ignition Development

It was clear to him from the outset that the then-common flame ignition would be quite useless for a high-speed engine, and so he invented a system of tube ignition which abolished the slide-valve needed with flame ignition, and was self-timing. The illustration shows how tube ignition worked. The ascending piston *B* forced the mixture into a hollow tube of platinum *F* which was kept at white heat by an external bunsen burner, and so detonated the charge. It was simplicity itself and was very common on cars until the turn of the century. I drove a large number of cars so fitted in the Victorian days. Its chief weakness was the possibility of the lamp becoming extinguished by either the

wind or the vibration of the road.

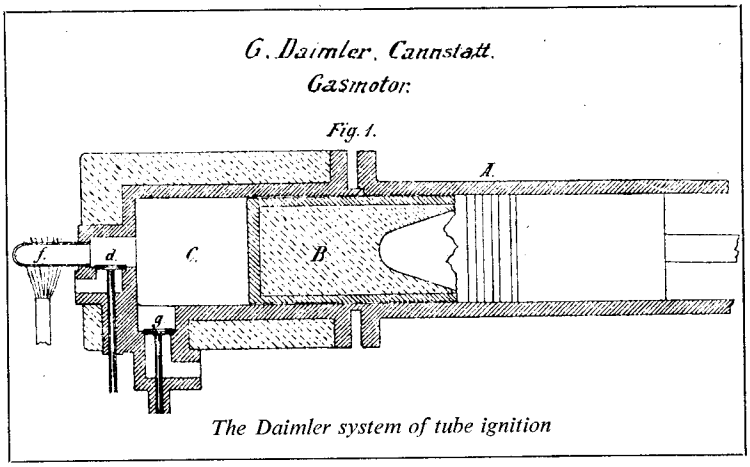
World's First Motorcycle

Daimler's first attempt to build a self-propelled road-vehicle was, curiously enough, a motor bicycle—the first the world ever saw—which is illustrated on this page. This machine was tried out on the roads by Daimler's eldest son, Paul, on November 10th, 1885. He drove it from Cannstatt to Untertürkheim and back, a distance of some three kilometres. The two side-wheels were fitted as it was thought that the weight of the machine and the rider would cause balancing to be difficult.

The First Car

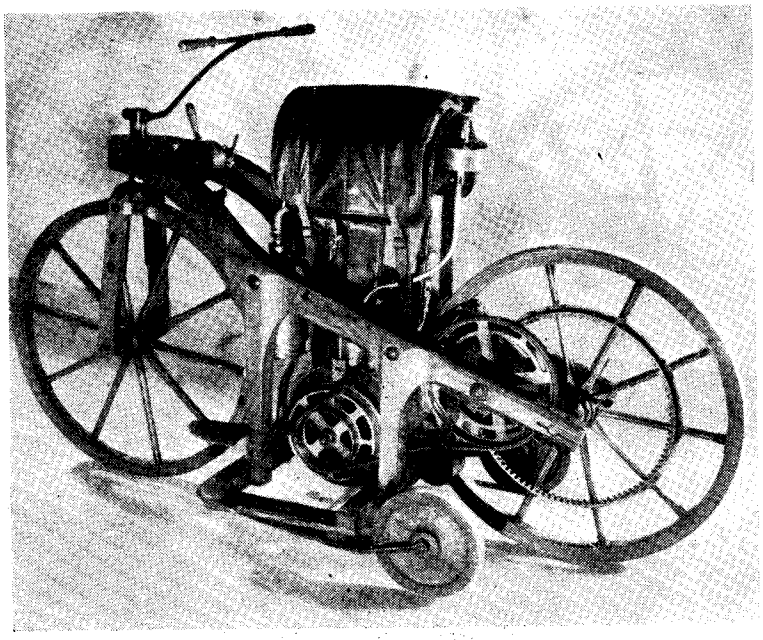
When Daimler came to design his first car, he was faced with a different set of difficulties. At first, it was his idea that when the internal-combustion engine became popular, every horse-drawn vehicle would be converted to one which was motor-driven—a strange idea, indeed. He had made a rough sketch of how he would fit an engine and transmission into a carriage, but before he could obtain a patent, he had to make one and prove that it would run under its own power. The strategy he employed was both novel and somewhat ingenious.

His wife, Emma—the daughter of a chemist in Maulbronn—would be celebrating her 43rd birthday on April 29th, 1886, and this gave him a hint. He purchased, ostensibly as a birthday present for his wife, a horse-drawn carriage of American type from a coachbuilder at Cannstatt, for which he paid 75 Marks. He specified that a number of alterations would have to be made to it, chiefly to strengthen it, and this caused a long delay in its delivery. He was very anxious for no one to know the real object of his purchase, and it was not delivered to him until August 28th of the same year, when it was pushed round to his house by the son of the coachbuilder, helped by two blacksmiths, after dark so that it would not cause much attention. It was finally man-handled into his workshop by his housemaid and the gardener.



The Daimler system of tube ignition

The shafts of the carriage were removed and a steering gear, of his own design, fitted. The whole of the front axle was made to swing round on a central pivot, instead of using the stub axles of today. A single-cylinder engine of 1½ h.p. was fitted amidships, as shown in the photograph, and a differential gear was improvised, this consisting of some leather discs which slipped when the rear wheels revolved at different speeds when rounding a corner. The system of belt-transmission he adopted will be readily understood. This, then, was the first four-wheeled motor-car with a petrol engine, which the world had ever seen.

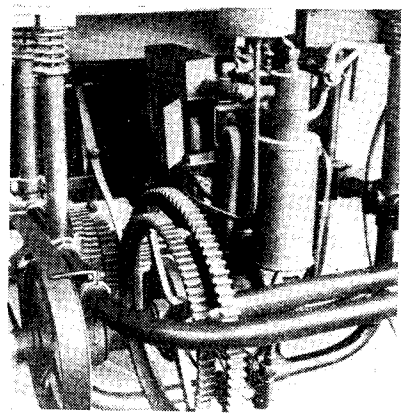


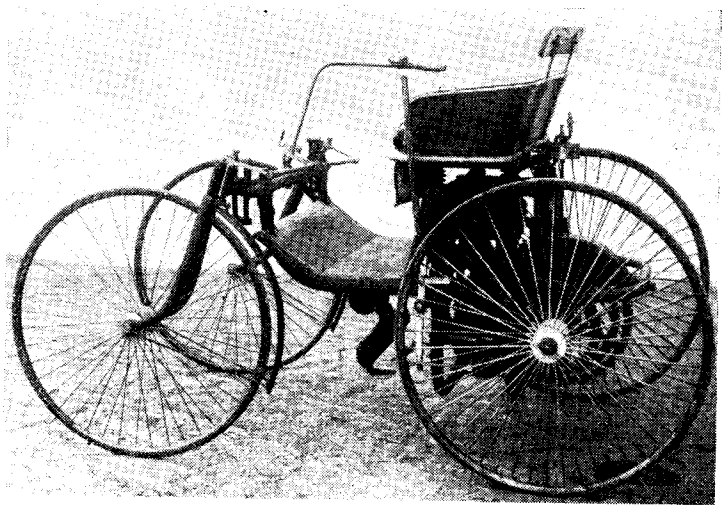
Motorcycle by Daimler—1885. *This was the world's first motorcycle*

Historic Event

It was in the autumn of 1886 that this vehicle was first tried out in the grounds of the Esslinger Engineering Company, and it was afterwards driven between Esslinger and Untertürkheim by Wilhelm Maybach—Daimler's life-long partner and friend—and by his son, Paul. This very car can now be seen in the Deutsches Museum in Munich.

This was followed by a second car in 1889 which is also shown in the photograph on page 375. It was a very different type of vehicle, being designed specially for the purpose and was not a converted horse-drawn carriage. It had a water-cooled single-cylinder engine, and a curious feature was that in lieu of a radiator, the water circulated through the tubular frame. The sliding change speed gear is also shown. This





The sliding change-speed gear of Daimler's second car. Right: The second car—1889

disposes of the old mistake about Emile Levassor having been the first to use a sliding change-speed gear on a motor vehicle. Levassor's car appeared in 1891 and Daimler's in 1889.

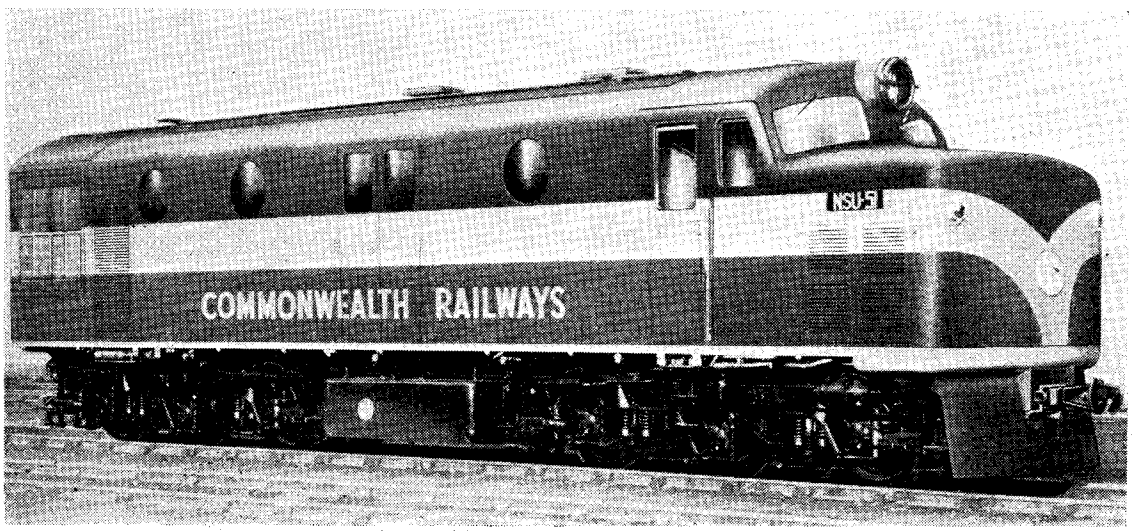
Unfortunately Daimler never lived sufficiently long to see his dreams come true. He died from heart trouble on March 6th, 1900 when automobilism was in an experimental stage. He saw the tree he planted come into bud, but never into flower.

It is an interesting fact that Daimler took part in the original "emancipation" run of motor vehicles from London to Brighton during November, 1896. He and my old friend, F. R. Simms went down together in a Cannstatt-Daimler car.

A BRITISH-BUILT DIESEL LOCOMOTIVE FOR THE COMMONWEALTH

A SULZER-ENGINED 955 h.p. 3 ft. 6 in. gauge locomotive, one of 14 built by the Birmingham Railway Carriage & Wagon Co. Ltd. for the Central Australia line of the Commonwealth Railways, ran trials between Smethwick and Banbury, Western Region, on February 21st and 26th. It ran on standard-gauge bogies made to Commonwealth order so that, if necessary, these locomotives could run also on 4 ft. 8½ in. gauge sections of the C.R. Locomotive weight is 62 tons, top speed 50 m.p.h., starting tractive effort 27,000 lb., and wheel arrangement A1A-A1A. A pressurised engine-room is a feature to keep out dust and sand.

As the locomotive is air-braked only, two quintuple sets of E.R. suburban stock were used as trailing load during the recent Smethwick-Banbury trials.



A MILLING ATTACHMENT - "PLUS"

By A. R. Turpin

SOME time ago I described what I called a "Dividing Head 'Plus,'" (THE MODEL ENGINEER, November 15th, 1951), and at the time I promised that at a later date I would describe a milling attachment to fit the special vertical-slide that went with it. I am afraid that it has taken me rather a long time to get down to this job, and by now there are a number of new readers who have not had the opportunity to make the vertical-slide. I have, therefore, designed this milling attachment so that it can be used on the ordinary Myford vertical-slide, or the type described in my previous article.

If the reader has already constructed the dividing head, then he can use his existing mandrel bearing, and the same mandrel. There are, however, one or two differences in the new bearing and the mandrel: In the former, the main bearing is no longer split, and in the latter, the length has been increased so that a cluster pulley and a back gear can be accommodated together, thus saving setting-up time. The mandrel also has been given a slight waist to form an oil reservoir. To utilise your existing mandrel and bearing the increase in mandrel length can be ignored if you don't mind a little inconvenience in operation, and it is an easy matter to turn off a few thou. from the diameter of it in the position shown. The fact that there is no adjustment for wear should not worry the amateur, because if the bearings have been properly lapped in they should give at least 2,500 hours running before showing signs of wear. The same castings that were used for the dividing head can be used for the milling attachment, and are obtainable from Mr. Haselgrove; the pulleys are some I happened to have by me, and the reader's are almost certain to differ, so care should be taken to note what difference they will make to the dimensions shown. The gear wheels are standard Myford change wheels; the large one is modified, but the others are used as supplied, so the actual lathe wheels can be utilised without harm.

Photograph No. 1 shows the milling attachment set up for cutting a clock wheel, with both the back-gear and the back centre in use. The milling cutter is mounted on a "draw-in" Morse taper shank. The large amount of overhang is necessary when cutting some of the larger wheels, otherwise the periphery of the blank tends to foul the mandrel nose; the use of the back centre gives plenty of support, however. The mandrel is being driven by means of a $\frac{1}{4}$ in. diameter plastic belt about two yards long, and this belt has sufficient stretch in it to allow a movement of about three inches to the cutter. I have found this plastic belting extremely useful, and have just discovered that it can now be obtained in sizes up to $\frac{3}{8}$ in. diameter which size would be better for this job. Do not try to stretch this belting to its maximum until it has run for a minute or so and gets slightly warm, otherwise the joint may break.

I have also found that if the belt is allowed to slip a great deal, it is likely to stretch and get slack, but if it is allowed to cool down it will go back to its original size, provided, of course, that the stretch was not excessive.

The motor was mounted on a length of 6 in. × $\frac{7}{8}$ in. boarding, and then screwed, clamped, or weighted down in any desired position. In the photograph, the back-gear is in operation, and the cutter turning at 600 r.p.m., whilst cutting a brass blank.

In Photograph No. 2, the attachment is shown mounted on an ordinary Myford vertical-slide, and the mandrel being driven by direct belt drive, the back-gear having been removed—it could, of course, just have been swung out of the way. In this case, the back centre is not required, because the cutter is mounted on a stubby spindle, held in a collet chuck with little overhang. By the way, the mandrel nose and the bore is finished to the same

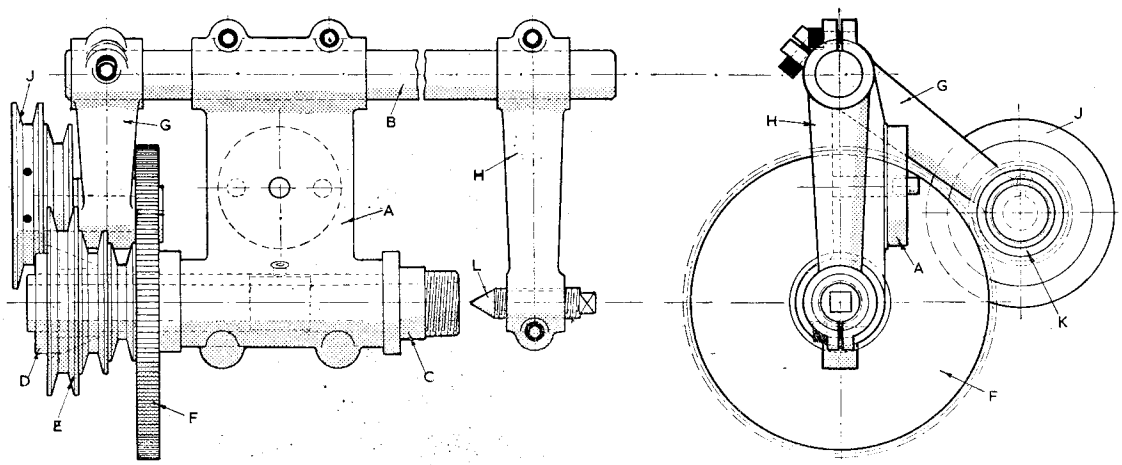
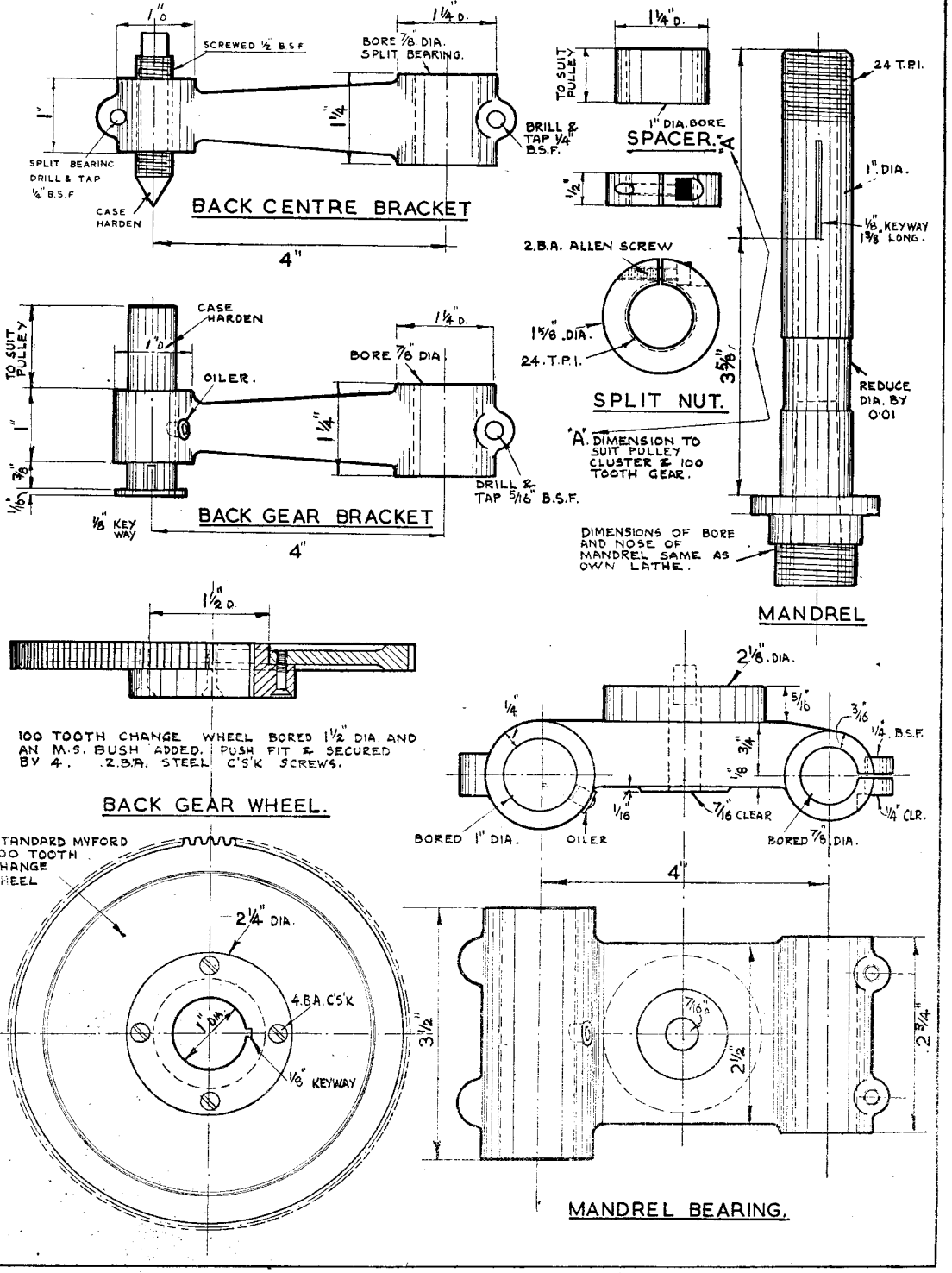
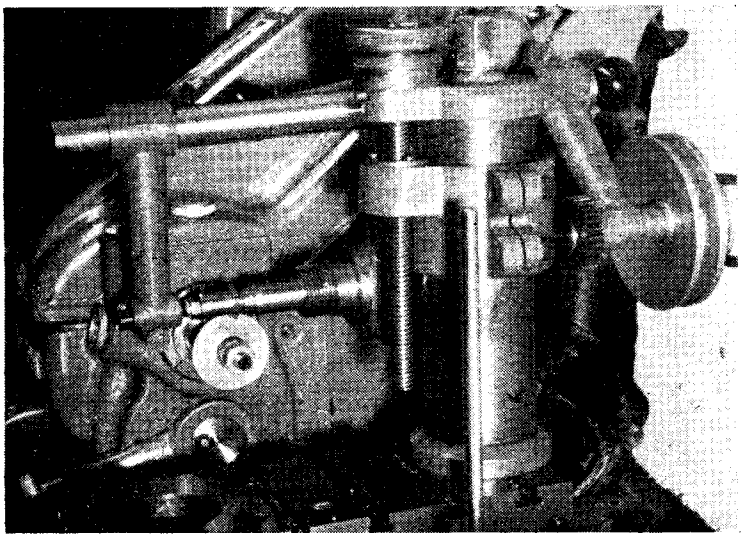


Fig. 1. General arrangement of the milling spindle


1" D.
SCREWED ½ B.S.F.
1¼" D.
BORE ⅞ DIA. SPLIT BEARING.
1"
1¼"
SPLIT BEARING DRILL & TAP ¼" B.S.F.
CASE HARDEN
DRILL & TAP ¼" B.S.F.
BACK CENTRE BRACKET
4"
1¼" D.
TO SUIT PULLEY
1" DIA. BORE
SPACER "A"
½"
24 T.P.I.
1" DIA.
⅛" KEYWAY 1⅜" LONG.
2 B.A. ALLEN SCREW
1⅝" DIA.
24 T.P.I.
SPLIT NUT.
3⅝"
REDUCE DIA. BY 0·01
"A" DIMENSION TO SUIT PULLEY CLUSTER & 100 TOOTH GEAR.
DIMENSIONS OF BORE AND NOSE OF MANDREL SAME AS OWN LATHE.
MANDREL
CASE HARDEN
1" D.
TO SUIT PULLEY
OILER.
BORE ⅞" DIA
1¼" D.
1"
1¼"
⅜"
1/16"
⅛" KEY WAY
DRILL & TAP 5/16" B.S.F.
BACK GEAR BRACKET
4"
1½" D.
100 TOOTH CHANGE WHEEL BORED 1½" DIA. AND AN M.S. BUSH ADDED. PUSH FIT & SECURED BY 4. 2 B.A. STEEL C'S'K SCREWS.
BACK GEAR WHEEL.
2⅛" DIA.
5/16"
3/16"
¼" B.S.F.
¼"
¾"
⅛"
1/16"
7/16" CLEAR
¼" CLR.
BORED 1" DIA.
OILER
BORED ⅞" DIA.
STANDARD MYFORD 100 TOOTH CHANGE WHEEL
2¼" DIA.
4 B.A. C'S'K
1" DIA.
⅛" KEYWAY
3½"
4"
7/16"
2½"
2¾"
MANDREL BEARING.



Photograph No. 1. Milling attachment set up to cut a clock wheel

dimensions as that of the ML7, so that the same collets, Morse taper spindles, and drill chucks can be used.

Photograph No. 3 shows the milling spindle being driven from the motor, which has been placed on the floor, and kept in position by heavy weights; this allows the carriage to move about 12 in. whilst a keyway is being cut in a drilling machine quill with a $\frac{1}{8}$ in. end-mill, held in a small Jacob's chuck. By the way, there is no chance of the Jacob's chuck coming off its Morse taper spindle, because I have drilled the body and tapped the spindle so that it may be secured by a 4-B.A. countersunk steel screw.

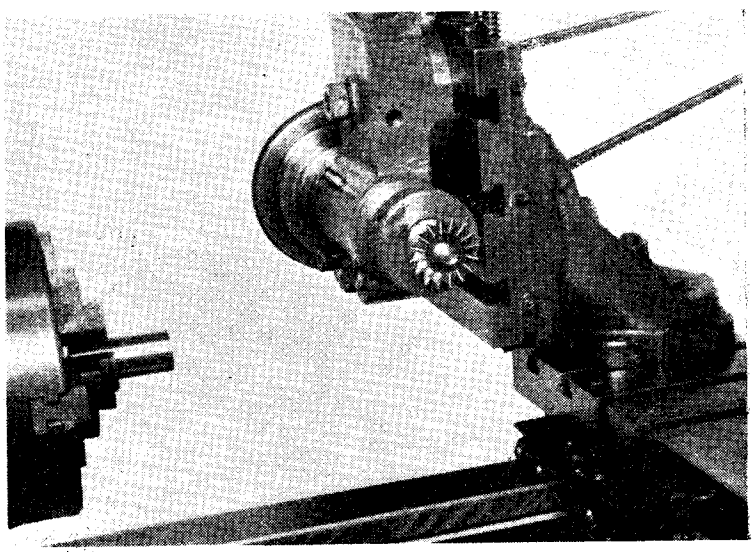
Photograph No. 4 shows how the mandrel may be driven by a flexible shaft when carrying out drilling at high speeds; this method should not be used below 1,000 r.p.m. A special expanding bolt is made to fit the rear end of the mandrel, and the end of this is gripped by the chuck of the flexible drive; the large back-gear wheel has been left in place purposely to act as a flywheel, and iron out any surges caused by the flexing of the shaft.

A description of the milling attachment is as follows: Referring to Fig. 1 the main body casting *A* is the same as that used for the original dividing head, and can be obtained from Mr. Haselgrove; this carries the support bar *B* and the mandrel *C*. The support bar bearing is split, as in the original, so that it may be clamped, but the mandrel bearing is not split, because it is thought that with the amount of work the amateur is likely to give such an attachment, wear will not be apparent during his lifetime, or 2,500 hours or more of continuous use. If the constructor feels he would like to have some means of adjustment, or it is desired to use the original dividing head which he may have already constructed, then, in order to make the bearing oil-tight it will be necessary to seal the saw cut with a piece of vulcanised fibre sanded down to be a tight fit in the cut. The base of the cast-iron body has no recess for a spigot unless it is to be used on the original design of vertical slide, but has two removable dowels fitted, so that it may be quickly aligned at right-angles to the lathe bed.

The mandrel *C* is of mild-steel, and the inside bore and outside dimensions of the nose are the same as that of the ML7, so that the collet and drill chucks, etc., are interchangeable; and any axial spindle adjustment is made by a circular split nut *D* on the rear of the mandrel. Also, at the rear end of the mandrel is carried a three-step pulley cluster *E*, and a back-gear wheel *F*. It is in order to carry both of these at the same time that the length of the mandrel has been increased, but provided that this small advantage is not required, the original type of mandrel may be used. It will be necessary to re-chuck it and take off a few thou. at the waist in order to give the bearing an oil reservoir.

The back-gear bracket *G*, and the back centre bracket *H*, are identical castings as originally used, but the small end of *G* could be both lengthened and thickened if a new pattern is being made. This latter bracket carries a case-hardened spindle, on which rotates the back-gear wheel *K* and a two step pulley *J*, the gear wheel is interchangeable with any other wheel, so that various ratios are available.

The mandrel is reversible in its bearing so that the attachment may be used left- or right-handed.



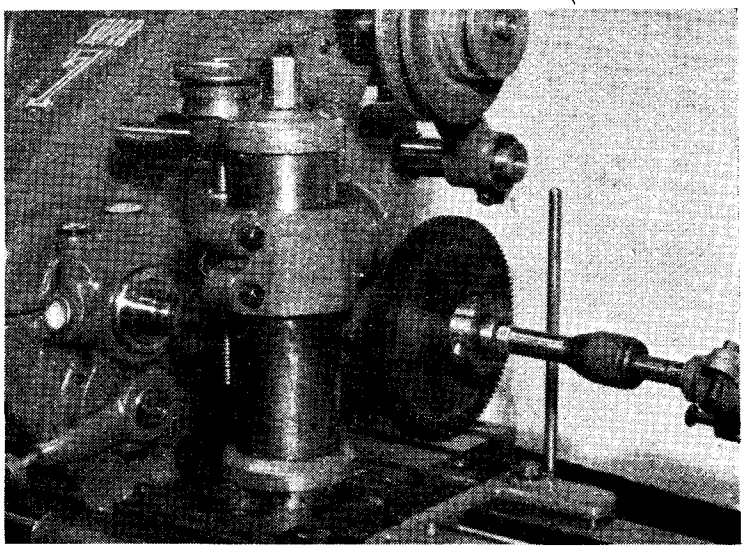
Photograph No. 2. The spindle mounted on a Myford vertical-slide

Construction

The Main Body.—This is cast with a chucking-piece on the top side, and should be held in the four-jaw chuck and adjusted so that the circular boss runs as truly as possible; the boss is then machined to size, the base surfaced, and the $\frac{7}{16}$ in. diameter hole drilled. It is important that when surfacing the base it is given a slight concavity—in new lathes this is usually automatic—the amount being no more than half-a-thou. or so; test on a surface-plate if necessary, and scrape as required. If the foregoing is not carried out, it will be found impossible to make the casting really grip the vertical-slide when the single bolt is tightened, on the other hand, if the machining is carried out as instructed, the attachment will have to be badly overloaded before it shifts.

The body is now reversed in the chuck, adjusted to run true, and the chucking boss turned off, leaving about $\frac{1}{16}$ in. proud, to act as a bolt-head seating.

The centres of the main bearing having been carefully popped, the casting is clamped to the cross-slide by the centre hole, packing being use to bring it to centre height of the lathe, and at the same time taking care that the bearing is truly parallel with the axis of the lathe bed. This can best be ascertained by inserting centres in the head and tailstocks, and bringing these up to the centre-pop marks on the casting. The drill chuck is now inserted in the head-stock, and the bearing first drilled, and then bored, using a boring bar, to 1 in diameter. Actually, it is easier to make this dimension slightly less than the round figure by a few thou. and fit the mandrel to it; in any case, leave at least 0.001 in. so that the bearing can be given a lapped finish. The ends are now faced by using a facing cutter in the boring bar, having a left- and right-hand cutting face, so that this operation may be carried out without turning the casting, thus making certain that both faces are parallel. Whilst this operation is being carried out, considerable pressure has to be exerted to cut through the skin of the casting, and it is advisable to arrange some kind of stop against the opposite side of the casting to prevent it shifting.



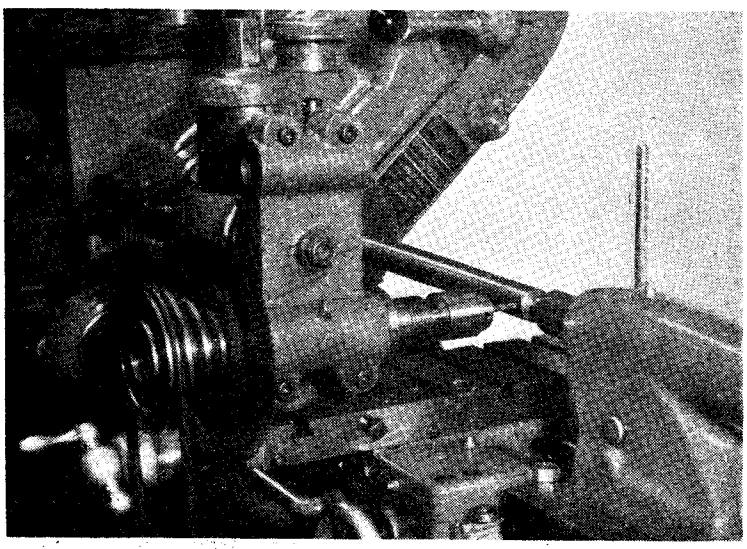
Photograph No. 4. *Using the spindle as a high-speed drill and driving it by a flexible shaft*

The boring of the casting having been completed, a careful note should be made of the reading of the micrometer thimble of the feedscrew, and having taken up any backlash, the screw is advanced exactly 4 in., and the bearing for the support bar bored out in the same manner as that for the main bearing; by this method, both bearings are accurately aligned and spaced.

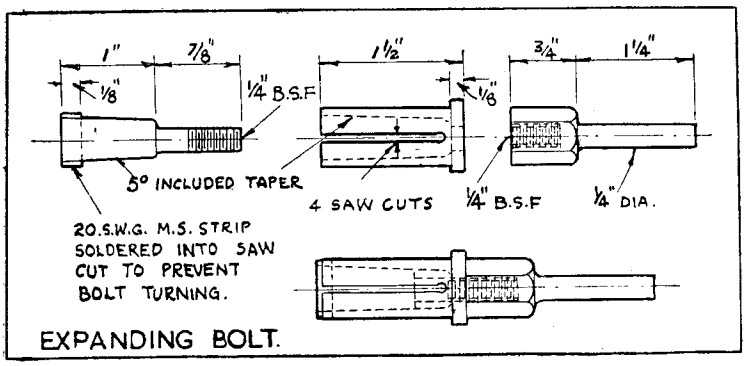
The Back-gear and Back Centre Brackets.—These are machined, using the same technique as that used for the main casting, but in this case the brackets are supported on two vee-blocks.

The Mandrel.—The method of machining this will be found to be somewhat different from that described in my original article, and it was suggested to me by one of my correspondents, but unfortunately I have forgotten which, and I apologise for no acknowledgment.

A suitable length of mild-steel is mounted between centres and rough turned to about 0.01 in. of the finished size. The four-jaw chuck should now replace the headstock centre, and the work adjusted to run dead true. Next, erect the fixed steady just behind the collar on the mandrel nose and adjust the fingers accurately so that the tail-stock centre may be withdrawn, still leaving the work running dead



Photograph No. 3. *Milling a long keyway, the driving motor placed on the floor*



EXPANDING BOLT.

true. Enlarge the centre hole with a centre drill having a ¼ in.. diameter body, to a depth of ½ in., this will give a true start to a ¼ in., drill, and if you have a long enough drill, drill the mandrel right through, otherwise drill as deeply as you can. Enlarge this hole by drilling to ½ in. diameter, going as deeply as you can each time. Now make a "D" drill long enough to go right through the mandrel, 19/32 in. diameter, enlarge the front of the drilled hole by boring to a depth of 1½ in., so that the "D" drill is a nice push fit. "D" drilling is slow work, especially when the whole of the metal has to be removed, but it gives an accurate hole.

Before the next operation is carried out, in fact, before any work on the mandrel has been started, a test should have been made on some scrap material, so that the cross-slide has been accurately set to cut an internal No. 2 Morse taper. I find this a very much more difficult operation to carry out than turning male tapers, and to finish the job really accurately I always use a taper reamer, either bought or home-made; I have also been told that it is a help if the tool is used inverted, but I have not tried it.

Let us consider that the top-slide has been set accurately to cut the taper; then, using a sharp boring tool, we can bore the mandrel No. 2 Morse. Care should be taken that not only is the taper accurately cut, but to the correct depth; if too shallow, or too deep, the collet chucks will not function. If a reamer is used to remove the final few thou., it is as well to make a tailstock holder for it so that it is truly parallel with the axis of the mandrel. The mandrel may now be removed from the lathe, and a double-ended Morse taper is turned up from ¾ in. bar, this is mounted between centres, and one end taper turned; which taper is then fitted into the headstock and the second taper turned on the protruding end. The partly finished mandrel is now pushed on to this protruding taper, and should run reasonably accurately; a very light skim at an angle of 60 deg. should be taken off the rear end of the bore, in case it is not quite true, and the back centre brought up—it will have to be a big one that isn't swallowed by the 19/32 in. hole (see Photograph No.5).

The mandrel is now finished to size, and the 24 t.p.i., on the rear end of the mandrel cut. This may all seem a lot of trouble, but it is a way of making certain that the interior Morse taper, the mandrel nose, and the bearing surfaces are dead true with each other. In order to cut the thread on the nose, the mandrel is mounted as before, using the four-jaw chuck and the fixed steady; even if this thread is somewhat out of truth and has to be made a few thou. slack, this will have no effect on the accuracy of any of the attachments. Finally, the bearing surface should be lapped to size and the keyways cut.

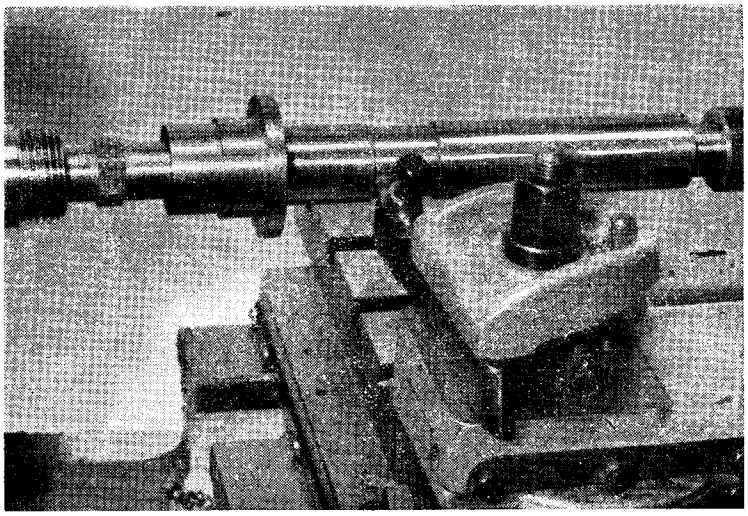
The only other item that requires special attention is the tapping of the screw thread in the back centre bracket, which is carried out when the whole job is complete. A ½-in. taper tap is mounted in a collet chuck in the mandrel itself; and, with the support bar, just loose enough in its bearing for the bar to be moved without rock, the back centre bracket is pushed up to the tap and the mandrel rotated by its pulley, causing the tap to screw into the hole truly square; once it has been well started, the bracket may be removed to the vice and the tapping continued in the normal way.

The back-gear wheels are Myford change-wheels, and it is only necessary to modify the large one, which is one of 100 teeth. This wheel has the centre bored out to a diameter of 1½ in., and then a mild-steel bush inserted as shown in the drawing. Of course, any size wheel may be used on the idling spindle, so that various gear ratios are available.

A test of the milling spindle was made at high speed, and using a "V" rope rubber belt, over 6,000 r.p.m. was held for 30 minutes.

The high speeds would only be used for fine drilling, the gear cutting being carried out at spindle speeds of between 100 and 600 r.p.m., depending on the material being cut and the diameter of the cutter.

The spacing washer may not be required; it depends on the type of cluster pulley used on the mandrel. Mine was deeply recessed.



Photograph No. 5. The mandrel mounted on a double-ended Morse taper for finish turning

L.B.S.C.'s Titfield Thunderbolt

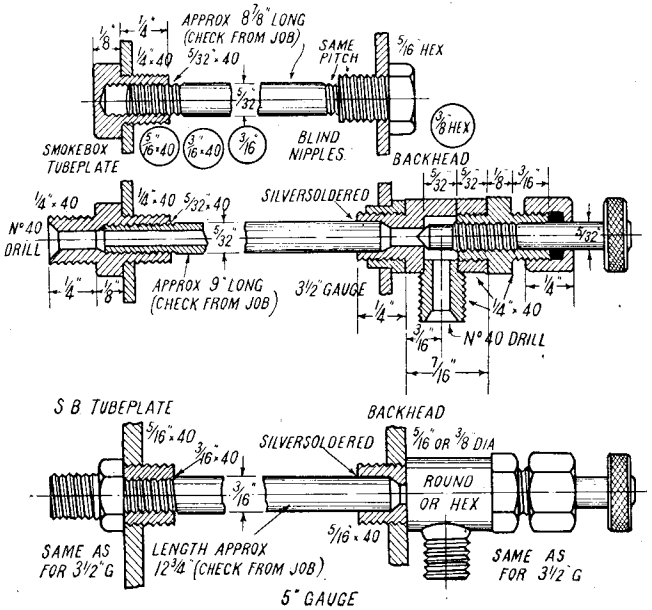
IN 3½ AND 5 INCH GAUGES

HAVING got over the business of staying the crown sheets and the square firebox shells, the rest of the job is plain sailing. The two longitudinal stays in the 3½-in. gauge boiler are just the same as in the usual type of boiler, running from the backhead to the smokebox tubeplate. The left-hand one is a piece of 5/32-in. round rod, drawn bronze for preference, but copper or gunmetal will do. Don't use brass or any brass alloy, as these tend to corrode and become brittle. It is fixed by a blind nipple at each end, made from $\frac{5}{16}$-in. hexagon rod. Chuck a piece in the three-jaw, face, centre, and drill a bare $\frac{5}{16}$ in. depth with No. 30 drill; tap 5/32 in. × 40. Turn down $\frac{1}{4}$ in. of the outside to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. × 40. Part off at a full $\frac{1}{8}$ in. from the shoulder, reverse in chuck, and chamfer the corners of the hexagon. Cut a piece of 5/32-in. rod long enough to reach from the backhead to the smokebox tubeplate, and put a few 5/32 in. × 40 threads on each end; screw one of the nipples on it, for about three threads, insert into the left-hand tapped hole in the backhead, close to the regulator bush, and guide it through the corresponding hole in the smokebox tubeplate, screwing the nipple home in the backhead. I've described the wheezes for guiding the rod to its destination, umpteen times already. Screw the other nipple on the protruding end of the stay at the smokebox tubeplate, driving it right home.

The right-hand stay carries the blower steam, as usual, and is made from 5/32-in. copper tube, not thinner than 20-gauge, preferably 18-gauge. It is attached to the blower valve at the footplate end, and to a thoroughfare nipple at the front end. To make the latter, proceed as described above for a blind nipple, but part off at $\frac{5}{8}$ in. from the shoulder. Reverse and rechuck in a tapped bush held in three-jaw; turn $\frac{1}{4}$ in. of the end to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. × 40. Centre deeply with size "E" centre-drill, and poke a No. 40 drill down, until it breaks through into the tapped hole.

To make the blower valve, chuck a piece of $\frac{5}{16}$-in. round or hexagon rod in three-jaw; face, centre, and drill down a full $\frac{1}{8}$ in. depth with No. 23 drill. Turn down $\frac{1}{4}$ in. of the outside to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. × 40; part off at $\frac{7}{16}$ in. from the shoulder. Reverse in chuck, centre, drill through with No. 43 or 3/32-in. drill, open out and bottom with 7/32-in. drill and D-bit to $\frac{5}{16}$ in. full depth, and tap $\frac{1}{4}$ in. × 40 for $\frac{3}{16}$ in. depth. Drill a 5/32-in. hole in the side, at $\frac{3}{16}$ in. from the shoulder; and in it fit a $\frac{1}{4}$ in. × 40 union nipple. I needn't repeat how to make *that* ! The piece of tube should be a shade over 9 in. long (check from job) with a few 5/32 in. × 40 threads on one end. Squeeze the plain end into the socket in the screwed end of the blower valve body, and silver-solder it, and the nipple, at the same heat. Quench in acid pickle, wash off, and clean up.

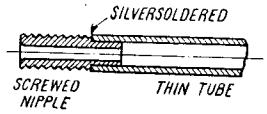
I might mention here, that I clean all my fittings, as I make them with a circular wire brush mounted on a short arbor with a taper shank, the relic of a worn-out drill. My grinder is of the usual type, a ¼-h.p. motor with a wheel at each side of it, mounted on the projecting ends of the armature spindle. There are a few threads showing beyond each wheel, so I made a screwed socket to take the place of the nut at the right-hand end. The outer end of this is reamed No. 1 Morse taper, so if I push the taper shank of the brush arbor into it, same is held tightly, and the brush runs truly. As the motor runs at 2,990 r.p.m. it only needs a few seconds' application of the fitting to the spinning brush, to get a bobby-dazzle shine. Warning: if the wheel has a wooden centre, keep your eyes out of the "line of fire." Once when cleaning some injector bodies after the silver-soldering process, a tuft of wires flew clean out of the wooden boss and caught me right in the face,



Details of longitudinal stays and blower valve

with the result that it looked as though I'd been having a dust-up with the cat. Since then, I've used wheels with a metal boss; they can be obtained from our advertisers. Safety first !

Put the tube through the right-hand stayhole, which is bushed on the 3½-in. gauge boiler, guide it to the hole in the smokebox tubeplate, and screw the blower-valve body home, so that the union nipple points to the right; the thoroughfare



Reinforcement for thin-tube blower stay

nipple is then screwed on the other end as shown in the illustration. Although the rest of the blower valve won't be needed yet, the bits might as well be made now; chuck the $\frac{5}{16}$-in. hexagon rod again, face the end, turn down a full 5/32 in. length to $\frac{1}{4}$ in. diameter, screw $\frac{1}{4}$ in. × 40, and part off at $\frac{5}{16}$ in. from the shoulder. Reverse and rechuck in a tapped bush, held in three-jaw; turn down $\frac{3}{16}$ in. length to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. × 40. Centre, drill through with No. 30 drill, open out for $\frac{1}{8}$ in. depth with No. 21 drill, and tap the remains of the hole 5/32 in. × 32, the coarser thread giving a quicker opening. Make a $\frac{1}{4}$-in. gland nut to suit; this is just the same as the oft-described union nuts. The spindle can be made from a piece of 5/32-in. rustless steel or bronze, 1⅛ in. long. Screw $\frac{1}{8}$ in. of it to match the tapped hole in the fitting, then turn away a full $\frac{1}{8}$ in. of the thread at the end, and turn a blunt cone point on it. The outer end is furnished with a weeny hand-wheel, about $\frac{3}{8}$ in. diameter, made from whatever material you fancy. I rather favour dural wheels, they look very nice. Others prefer fibre wheels, as they don't burn thin-skinned fingers, and some pains-taking merchants make them from rustless steel. Punch a square hole in the centre, with a little punch made from a bit of 3/32-in. square silver-steel (don't forget to drill a round hole first !) and file a square on the end of the valve spindle to fit. Drive the wheel on to the square, and rivet over slightly. Assemble as shown in the illustration.

Variation for the 5-in. Gauge Boiler

The full-length solid and hollow stays for the boiler on the 5-in. gauge engine, are made and fitted exactly as in the smaller one; but they are a little bigger, viz.: $\frac{3}{16}$ in. diameter. The blind nipples are made from $\frac{3}{8}$-in. hexagon rod, drilled 5/32 in. or No. 22, and tapped $\frac{3}{16}$ in. × 40. The outsides are turned down to $\frac{5}{16}$ in. diameter, and screwed $\frac{5}{16}$ in. × 40. The hollow stay is made from a piece of $\frac{3}{16}$-in. diameter copper tube, 16- or 18-gauge (preferably the former) approximately 12¾ in. long. The only difference in the thoroughfare nipple at the smokebox end, is that the part that screws into the tubeplate, is $\frac{5}{16}$ in. diameter, screwed $\frac{5}{16}$ in. × 40, and the hole in it is tapped $\frac{3}{16}$ in. × 40.

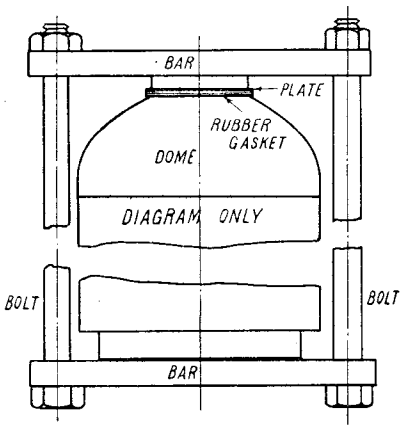
The blower valve for the 5-in. gauge boiler is the same as the smaller one, except that the bit that screws into the boiler backhead (no bush is needed in the 13-gauge plate) is screwed $\frac{5}{16}$ in. × 40, and drilled No. 14, for about $\frac{1}{8}$ in. depth, to take the end of the $\frac{3}{16}$ in. stay tube. The whole issue is assembled and fitted in exactly the same way as in the smaller boiler. As all regular readers know full well, it is my practice to keep the backhead fittings as small and neat as possible, *consistent with working efficiency* (that's the rub !) and the specified size of blower valve is ample for the needs of the 5-in. gauge boiler. By the way, I've often been both interested, and amused, at seeing photographs, and hearing the virtues of "scale" fittings extolled by various good folk; but I notice that the latter give no detailed description as to how to make them, nor any specific accounts of their working efficiency—my guess is that they haven't any !

If by any chance, you don't happen to have a piece of 5/32-in. or $\frac{3}{16}$-in. copper tube of requisite thickness for the blower stay, a piece of thinner gauge can be used, if a piece of drilled rod is silver-soldered to the end of it, to form an extension which can be screwed, instead of screwing the pipe itself. If thin pipe is screwed, it is very liable to break at the last thread. Turn about $\frac{1}{8}$ in. of the rod, to fit the end of the pipe, silver-solder it in, cut to length, screw the outside as given for the pipe, and centre and drill a $\frac{1}{16}$ in. or No. 52 hole through it, as shown.

The larger boiler needs two extra stays in the upper part of the firebox shell, parallel with the centre-line of the barrel. These *could* be put in, same as the full-length rod stay; but as poor old Inspector Meticulous might faint right away if he saw two big hexagon heads on the front of the firebox casing above the boiler barrel, we had better dispense with them, and keep our consciences clear ! Make two more blind nipples, same as used for the long rod stay; cut two pieces of $\frac{3}{16}$-in. round bronze or copper rod, each approximately 4⅜ in. long, putting $\frac{1}{8}$ in. of $\frac{3}{16}$ in. × 40 thread on one end, and a full $\frac{1}{4}$ in. of same pitch on the other. Screw the nipples on the longer threads, insert the stays through the upper stayholes in the backhead, and screw the ends into the tapped holes in the front of the firebox shell. They should stand out about $\frac{1}{16}$ in. when the nipples are screwed right home. Rest the nipple on something solid, and carefully rivet over the projecting bit of stay, into a neat head. It would be advisable to soften the ends before inserting, to make the riveting easier. These stays pass through the holes in all three girders.

Firebox Stays

The firebox stays are of the same type as used on British Railways standard locomotives; and as these engines are the result of the combined efforts of all the "locomotive brains" since the days of the old *Rocket*, further comment is superfluous ! The same size of staybolt is used in both boilers, the only difference being in the number and spacing. The location of all the



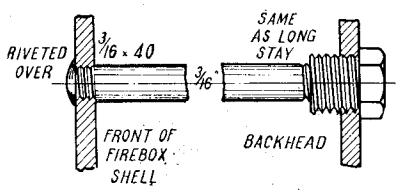
How to seal manhole flange when testing boiler

stayholes, except those in the 3½ in. gauge boiler backhead, can be seen in the drawings already reproduced. In the backhead mentioned, set out the six as shown on the front of the firebox shell, and put in another row of three, exactly above them, at a distance of $\frac{9}{16}$ in.

After marking out the location of

all the stays, on either boiler, drill the holes clean through both plates with a No. 40 drill. This should be sharp (beginners should, if possible, use a new one, which should cut a hole of correct size for tapping) and if lubricated with the same kind of cutting oil used for turning steel, it should make perfectly clean true holes, which is important for stay-holes. The holes can then be tapped with a $\frac{1}{8}$-in. or 5-B.A. pilot tap. Our advertisers sell these, made specially for staybolt tapping, so it isn't worth the trouble of making one's own, though I've made quite a number, and given some away. The pilot tap is necessary to ensure continuity of thread in both plates. Use plenty of cutting oil when tapping, to avoid torn threads ; there is a knack in tapping perfect threads in soft copper, but it is easily acquired. It needs patience, I freely admit, to tap all the stayholes in the larger boiler, and the average worker may find it boring; but it never worries your humble servant. I've made such a lot of boilers that I do it in a sort of mechanical fashion, with my mind far away. I've often solved some small problem concerning locomotive design and operation, while tapping stayholes !

Before I had the Diacro rod-parter, my method of making the staybolts was to cut about half-a-dozen 6-in. lengths of copper rod of right diameter, and screw both ends of each piece, for a distance equal to the width of the water-space plus the thickness of both plates, plus another $\frac{1}{8}$ in. for the locknut. The stuff I used for staybolts was very soft; a friend gave me a large number of offcuts from high-tension overhead cables, and the strands from these, when unravelled and straightened, were the exact size for 5-B.A. stays. Using a sharp die



Extra wrapper stays for 5-in. gauge engine

and plenty of cutting oil, perfect threads were produced and the stays fitted the holes just right. I put a tap-wrench in the middle, screwed the threaded end of the rod through the two plates as far as it would go, and snipped off the rod about $\frac{1}{16}$ in. from the wrapper. A brass lock-nut was screwed tightly on each stay, inside the firebox, as they were inserted.

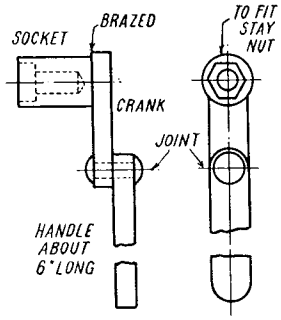
When all the stays were in, a stout bar of iron was placed in the bench vice, projecting from the side, each staynut rested on it, and the stub of rod outside the boiler, hammered over into a neat head. I did not bother to use a snap, as the heads were usually covered by the cleading plate. The nuts were given a final tighten-up after the stays had all been headed. When I had used up the threads on all my pieces of rod, I re-screwed them, repeating the performance until they were too short for further use. All the screwing was done in the lathe, with the pieces held in three-jaw, and the die in the tailstock holder. I cannot recommend a more satisfactory way of staying the fireboxes of the *Tit* boilers; and should bar, absolutely and completely, any idea of using plain bits of rod, or bits screwed at one end only, and fixed by any " brazing " material containing any phosphorus, or even silver-solder. I repeat, as a " danger signal," that this latter method renders the stays very brittle at the part where they emerge from the plates, and the expansion and contraction of the boiler will eventually cause some of them to fail. This is no idle warning; experience teaches !

Articulated Spanner for Stay-nuts

Plenty of beginners are tackling the 3½-in. gauge *Tit* as a fairly easy and simple first attempt—which is evidence of their wisdom—and to save them the trouble of asking how the merry dickens they are going to tighten the stay-nuts right up inside the firebox, I'd better recall my pet wheeze. Make an articulated box-spanner; it is only a few minutes' job. The illustration shows how; just drill a shallow hole in a stub of steel rod, to the diameter of the nut over the corners. Put a nut in, and hammer the rod down on to the flats, to get the right shape and size. Braze a short strip of steel to the end, and rivet a longer strip to the end of the short strip, leaving the joint loose enough to allow the strips to move easily on each other. The long handle enables the socket to be slipped over the nut without trouble, and no description is needed for turning the socket, thus tightening the nut, by aid of the handle.

Sweating up the Stays

If the threads on the stays are fairly tight in the tapped holes, and the nuts properly tightened, the firebox should be water-and-steam-tight without further attention; but in case there are any torn threads which might cause a few teardrops to be shed, the heads and nuts may be sweated over. Lay the boiler on its side in the brazing pan, and brush some liquid soldering flux over all the heads and nuts. Heat



Jointed stay-nut spanner

with a blowlamp until the flux boils off, and a bit of strip solder (preferably plumbers', but tinmans' solder will do) will melt as soon as it touches the hot copper. Melt a little among the heads, keeping up the heat, and brush it all over and around the heads and nuts, with a wire brush. This can be home-made in a jiffy, by putting a small bunch of iron wires in the end of a bit of copper tube, and flattening it. Put a bit of wood in the other end of the tube, to serve as a handle, as it will get too hot to hold, in double-quick time.

When one side is done, ditto repeato process on the other side, then up-end the boiler, and do the stays at each end of the firebox. When every head and nut is covered, shake off any surplus solder, let the boiler cool slightly until the solder has set, then wash well inside and out, to remove all traces of the flux. I use hot water for this job. If there are any traces of soldering flux left, a green deposit usually forms, and this isn't very beneficial to cuts and scratches.

The mild heat needed for sweating the stayheads and nuts, has no effect whatever on the metal of the stays, and they are not weakened, nor rendered brittle at the points where they enter the plates. Consequently, expansion and contraction stresses have no effect on the stays, and they effectually perform the job for which they were put in the boiler.

The boiler can then be tested by water pressure, in the manner which I fully described in the *Tich* notes;

(*Continued on page* 392)

MUSICAL MECHANISM

THE RECONSTRUCTION OF AN OLD POLYPHON

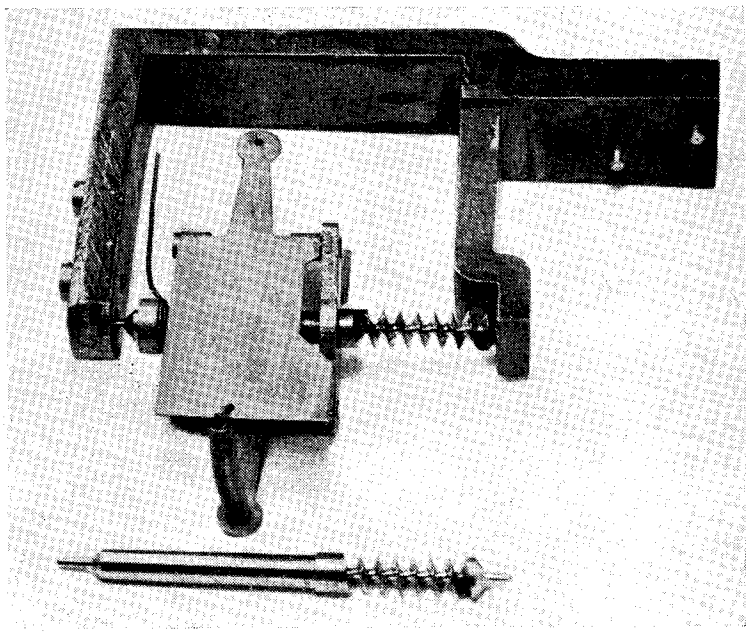
By "Aeolus"

THE clockwork mechanism had sustained a broken mainspring, and the main brass gear wheel was found to have been badly botched, in that two groups of five teeth had been repaired [*sic*] by screwing one short No. 4 B.A. steel screw into about the centre of each gap, and filling up the interstices with soft solder. Thereafter, it appeared that the teeth of the gears had been forced together to mould or shape the solder to gear tooth form. Of course, the solder was not "man" enough to support a stress such as is exerted by the mainspring, so the inevitable happened; the small pinion jammed in the solder which built up before it, distorting some of its leaves, or teeth, and stopping all movement either way. In addition to the above, the pivots of the "endless screw" were bent, the endstone was badly pitted, its securing finger plate was bent and, also, the female part of the stopwork was missing.

Warning! In case any unsuspecting reader should have cause to repair the clockwork of a music box of large size, it is necessary to sound a grave warning at this point. The main-springs are dangerous, in fact, they can be lethal if they get out of control. Their power, if suddenly released, is phenomenal, and precautions must be taken to stop them from "taking charge." When a mainspring is broken, the clockwork may be dismantled with impunity (but *not* the mainspring from its barrel or cage). If it is not broken, there is danger in unscrewing any part of the movement until there is definite verification that the spring has been fully "let down."

The pivots of the "endless screw" obstinately refused to be straightened; finally, they broke off. Blanks for new ones of B.M. steel were easy to turn, but cutting the worm thread presented several problems. Among others, there being no "run-out" at either end of it (see Photograph No. 7) and the core of the thread being extremely small in diameter, there was no possibility of doing the work by single point tool screw-cutting methods. The pitch of the worm is 10 t.p.i. and the only way to cut one with the equipment at hand was by rotary cutters. Of these, quite a number were made in various sizes and forms, but the worm-thread is so deep and of such odd shape that the success in spoiling blanks soon exceeded enthusiasm for making them. Various ways of supporting the component were tried, and, of course, light cuts were taken, but no satisfactory results were achieved, so Clerkenwell was searched for some form of cutting tool that might accomplish the job. A set of small burrs or rotary files were found that looked like doing the trick by slowly "chewing" or "carving" out the metal to something pretty close to the depth and contour required.

A blank was set up in a jeweller's 8 mm. collet, close to the nose of the mandrel of the lathe. The change wheels were arranged for cutting 10 t.p.i. and the belt drive of the headstock was removed. An 8 in. metal disc was fitted to the rear end of the lathe mandrel in order to move or inch it round by hand. A drive from the lathe motor (by flexible shaft) was rigged up so that the burrs were rotated in a simple milling head, clamped to the slide rest, by which latter they could be fed into the work. Care was taken to see that all back-lash was fully taken up each time the tool was presented to the blank; this was especially necessary owing to the number of passes that had to be made. The revolving burr was fed in 0.003 in. at the beginning of a cut, the mandrel (and thus, the blank) was slowly turned as regularly as possible by hand, until the end of the helix was reached, when the tool was withdrawn. Subsequent cuts were taken in the same way and the increments of feed on the burrs regulated by the index on the cross slide. This sequence was continued until the worm threads were deep enough. The form of the worm was then improved by using burrs with heads of various types at various angles until the job was not visibly "out." The surface, as left by the burrs, was hopeless for the purpose required because "endless screws" must be burnished to a brightness approaching the look of plating. The worm wheel contacts only the three central threads of the "endless screw," so these were touched up with a worn fish-back needle file, which removed some of the worst of the roughness. A fine slip stone was cut as nearly as possible to the thread form and the roughness still further reduced. During both these processes, the work was rotated against a solid support with one hand, while the tools were manipulated with the other.



Photograph No. 7. Above: The "endless screw," "fly" and C.I. frame for Polyphon music-box, found in Farringdon Road. Below: The home-made "endless screw"

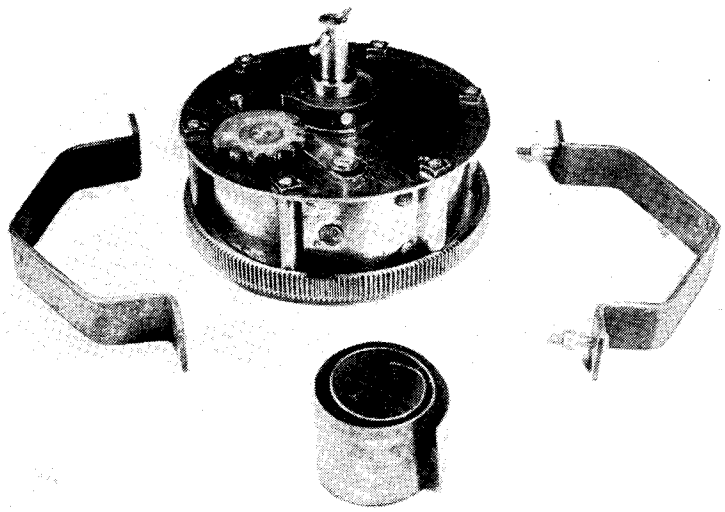
Continued from page 360, *April* 1, 1954.

The work-piece was replaced in the lathe and run under power at slow speed. With it was meshed a replica of the worm wheel, made of brass (this had been cut with a specially made milling cutter, by means described in articles on gear cutting in these pages) and mounted on a spindle carried in bearings clamped in the toolpost. This spindle could be retarded by the fingers. After protecting the slides of the lathe, flour emery and thin oil were fed on to the two revolving parts and they were lapped, or rather ground together until they fitted. This brought the surface of the "endless screw" to a finish suitable for burnishing with a hand burnisher made for the job. This completed the "endless screw."

The broken mainspring and its associated assembly were inspected, and as the mainspring's full expansive force was exerted on the six posts between the main brass gear wheel and the mainspring cover, the latter could not be removed without the posts bursting or bending outwards, thus making it impossible to replace the cover, which is held by nuts on the threaded ends of the posts. See Photograph No. 8. Two clamping straps were therefore made to go round the outside of the mainspring and posts. These, with the broken end of the spring are also shown in Photograph No. 8. The straps were pulled up with 2 B.A. high tensile bolts and nuts, and where they bit the posts, they were hammered with a copper faced hammer to jar the mainspring to a small enough diameter to release the tension between the posts and the cover. After much careful tightening of the strap bolts, and judicious persuasion with the hammer, the cover was released and removed without damaging the threads on the posts. The mainspring was then opened up for inspection, the central shaft withdrawn and the broken piece removed.

The method used to rectify the mainspring did, admittedly, cause a certain amount of set or twist to appear at the inner end of it, but this was better than removing it althogether from its cage and having to make a heavy spring re-winding jig to get it back into place. Complete removal might also have entailed damage to the main brass gear wheel, which is not too robust.

Two pieces of $\frac{1}{8}$ in. by 2 in. steel strip were each drilled to fit on the threaded ends of three of the posts, and positioned to overlap the mainspring to within two or three coils of its inside diameter. Two toolmaker's clamps were securely fixed



Photograph No. 8. Mainspring in cage showing stop-work. Right and left: Two clamping straps for holding mainspring while cover of cage was removed. Below: The broken piece of main-spring

on the parts of the mainspring not covered by the two strips, to guard still further against "flying." The mainspring cover nuts were tightened on the two strips, thus making all secure.

The middle three or four coils were pulled out of the cage until clear of the strips, where they, of their own volition, sprang upwards and outwards, but only sufficiently to prevent them from going back and to permit a gas blow-pipe to be used on the end of the mainspring to soften about two coils of it. The word "pulled" above, is an understatement; considerable leverage had to be used. When soft, the extreme end of the spring was squared, and a new hole (copied from the broken end) was made to accommodate the hook. This was an ordinary drilling and filing operation, hindered and made aggravating by the awkwardness of the position of the end of the mainspring and its natural lack of stability, to say nothing of the need for treating it warily. The end of it was afterwards forced back into its normal position, with a sigh of relief. Owing to having been strained outwards, the mainspring now protruded about 1 in. above the cover level. This was partially corrected by removing the $\frac{1}{8}$ in. by 2 in. retaining strips and the clamps, and inserting wedges under the undistorted coils, i.e., between them and the spokes of the main brass gear wheel (no easy matter) and pushing the upwardly bent coils downwards. This reduced the "out-of-flat" misalignment of the mainspring to between $\frac{1}{4}$ in. and $\frac{3}{8}$ in. This was considered good enough because only light pressure with the fingers was sufficient to press the centre coils into their proper position. The soft coils were bent so that the hole would definitely engage with the hook, and the spring assembly was put together. When the nuts securing the mainspring cover were tightened—and not till then—the two outside clamping straps were removed.

Limitations of space compel the omission of descriptions of repairs to the main brass gear wheel, the endstone and sundry other renovations. Having no idea of the shape of or number of teeth on the lost stop-work, an enquiry was sent to the author of the best book on music boxes that I know. In response, a new one was presented to me. Suitable acknowledgments will be made to the kindly donor later.

After the clockwork movement was repaired and re-assembled, there was some (expected) difficulty in getting the "endless screw" to run freely and correctly in relation to the worm wheel. Makers of music boxes did not, as a rule, set worm wheels to run centrally and in true alignment with "endless screws." In the case of the Polyphon, it is set a little above centre. The setting is critical and took time to find. Adjustment was made the more difficult because mesh depth had to be exact, and the worm wheel at the required offset. In other

words, two adjustments had to be attained simultaneously, and one did not know if either was correct until both were right. Had the two components been new and accurate, the setting might not have been so tricky. After the dual setting was found, the pivot friction reduced and the endstone properly set, there was no more trouble.

Delicate Adjustments

The re-erection and adjustment of the music playing part of the instrument was the most delicate task in the reconstruction. First, the combs were fixed in position with the dowels in the original holes. The end positions of the combs were marked with a scriber on the base-plate. The combs were then removed and the dowels extracted. They were replaced without dowels, and each was moved up towards the centre of the machine by 0.012 in. at the bass end and 0.007 in. at the treble. To do this, steel blocks had been clamped to the base touching the two outside corners of each of the combs at the first setting, and at the second, between the blocks and the combs, feelers were used to measure and verify the new positions. When satisfactory, the combs were securely fixed, the base turned over, and the dowel holes were opened in both plate and combs, and reamed to a size just sufficient to bring them into true circumferential relation. New dowels were then fitted. This movement of the combs was a correction for the amount of metal worn and removed from the tips of the tuned teeth, plus part of the wear (guessed) on the tips of the star wheels. There was no subsequent alteration to the dowels. Further adjustment up to a few thousandths of an inch (plus or minus) was obtained by packing with steel shim, either at the back or the front of the comb seating. The figures given (0.012 in. and 0.007 in.) may only be valid for this particular machine. On any other, they might have to be varied to suit the wear that had taken place.

With the combs again removed, the star wheels and jockeys were replaced in correct sequence in their mountings (see Photograph No. 5) and the shaft pushed home and re-pinned after seeing that the star wheels were all free. They were, of course, oiled.

The overhauled sets of dampers were set up in position and adjusted so that a brake exerted pressure on one side of each of the star wheels, and so that the damper arms moved backwards and forwards as the teeth of the star wheels came against them —as previously described. This and getting the curved part of all the dampers to just the right height was a lengthy business, but, gradually, as the job was better understood and known and little measuring aids devised, it became easier.

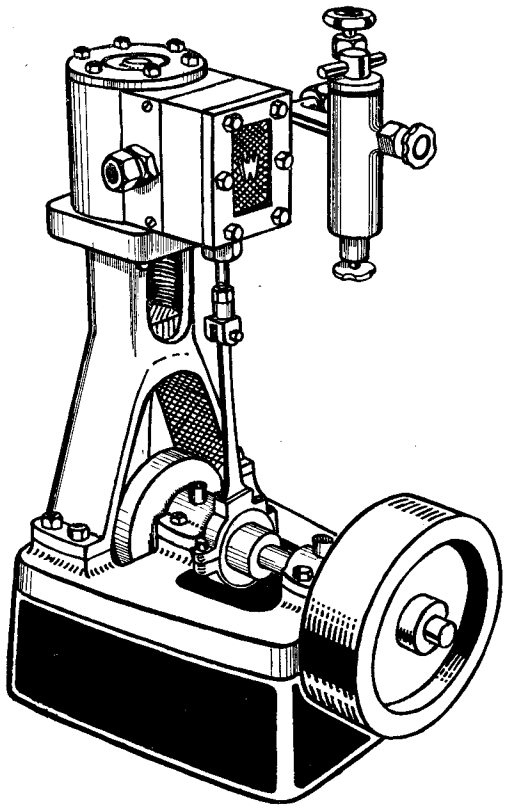
When all the dampers were set up and were, to all appearances, in order, all the star wheels were turned to a position in which they would hold the dampers *away* from the tuned teeth of the combs. If not set in this way, the tips of the tuned teeth will push against the dampers while the combs are being fitted, and if the teeth stand the strain, the dampers will not. As it was, when the right-hand comb was tried in position, the tips of the tuned teeth (or some of them) rested on the tops of the brakes, thus indicating that the brakes (and, hence, the dampers) were too far from the centre of the star wheels. So the dampers had to be reset again, to my short-lived chagrin. After a few more attempts, the whole of the dampers worked and each individual tooth received full damping effect from its damper.

Having got the musical part of the " works " into reasonable order mechanically, the lining up of the spigot that goes through the centre of the playing disc was attempted. This is not made simpler for a tyro by the fact that it is off-set about $\frac{3}{8}$ in. to the left of the star wheel axis, as can be seen in Photograph No. 4. Remembering that I possessed no knowledge of this when the reconstruction was commenced, I do not wonder why it took so long to attain a reasonable musical standard. In order to examine the working of the disc lugs against the tips of the star wheel teeth, a useless disc was cut radially, and the problem studied in the light of what could be seen by moving the disc backwards and forwards slowly, by hand. Although the action of the lugs on the teeth of the star wheels can be seen through the slots of the discs (with strong illumination shining from beneath), this was found to be of little value until the spigot was close to its proper position.

With the aid of the cut disc and a deal of trial, the spigot was, at length, brought to an effective position on the horizontal plane. The vertical plane was not so difficult to locate accurately. If the spigot is too high (or low) the lugs on the disc will be raised (or lowered) and thus will not meet the star wheel teeth fully and squarely, and will tend to strain them in passing. If the error is greater, the lugs may play one tooth higher (or lower) than the correct one. This, naturally, will be carried on throughout the whole scale. In the initial experiments in obtaining the correct vertical position, the cut disc was a great help. All final adjustments in spigot alignment were done by peering through the slots in the best disc available. When all was correct, the spigot was dowelled. After this, a disc was mounted on the spigot and the clamp arm was tried in place. This showed that the lugs were pressed too far into mesh with the star wheels, and also that larger jockey pulleys would be required on the star wheel shaft. It proved possible to withdraw the shaft without the star wheels getting out of position or disturbing former settings. The other spare jockeys of various larger sizes were tried until a pair was found that was right, and then the central shaft was replaced and re-pinned. The pressure exerted by the six rollers mounted on the clamp arm on the disc, though not critical, had to be such as to hold the latter up to its job, but not enough to prevent the easy working of the finger-operated spring clip in the banjo. This adjustment was obtained by packing the central spigot with shim—this does not affect the dowels—and the bracket holding the lower end of the clamp arm.

With the music-playing part of the mechanism on the bench, and with a reconditioned disc mounted upon it, a tune could now be played by turning the disc by hand. The results thus obtained were not good musically, it being impossible to turn the disc evenly; the resistance of the lugs on the star wheel teeth caused the disc to move in jerks. It was good enough to show that there was nothing radically wrong with the complete sub-assembly, which was therefore set up in the cabinet. A few more adjustments were made to bring the semi-spherical studs on the driving " gear " wheel into the centre of the holes round the edge of the playing discs, and the job was finished in all essentials. There remained the fitting of keys to the locks, adjusting the penny-in-the-slot device and sundry other small renovations. But the machine played well, and there was nothing further that could be done to improve on this, at least, not by me. The pleasure the instrument now gives in fulfilling its prime function, that is, dispensing music of high quality, adds rich reward to the happy workshop hours spent in getting it into playing condition. These hours were spread over about a year and

(*Continued on page* 388)



Constructing a "WARRIOR"

By Donald D. Eames

THE following ¾ in. × ¾ in. double-acting slide-valve steam engine is named the "Warrior," built by the writer, but designed by E. T. Westbury. I think it is one of the first of his range of utility steam engines the construction of which was so ably described by him in the pages of THE MODEL ENGINEER.

The machining was quite straightforward except perhaps for the baseplate and column, which were a bit tricky and called for some care.

The main bearings were cast integral with the baseplate, so the first operation was to split these and bolt down the caps. Next, a heavy centre-pop was made both ends, and putting a 15/64-in. drill in the three-jaw chuck and steadying the other end of the baseplate against either the back centre or a piece of coned rod held in the tailstock chuck, the first bearing was drilled. The other bearing was drilled by reversing the baseplate (Fig. 1). The bearings were then finished off with a ¼ in. reamer. For those fortunates with a shaping machine, the raised bosses for bolting down the column can be faced off easily enough. My method was to fix the baseplate on to the faceplate and face off by pulling the lathe belt round by hand.

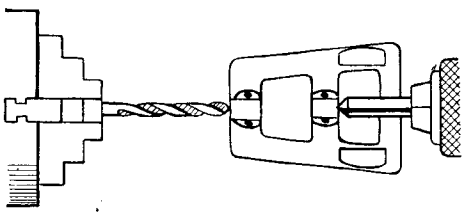
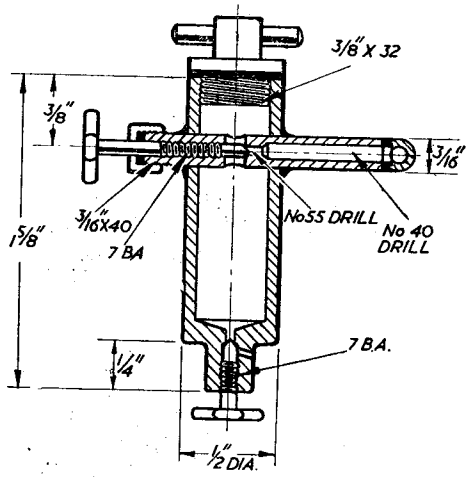


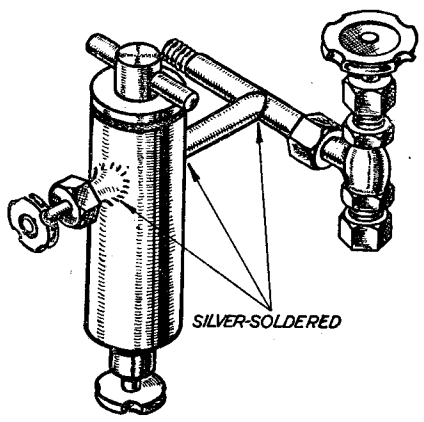
Fig. 1.

The feet of the column were cleaned up with a file and attached to the faceplate by dogs.

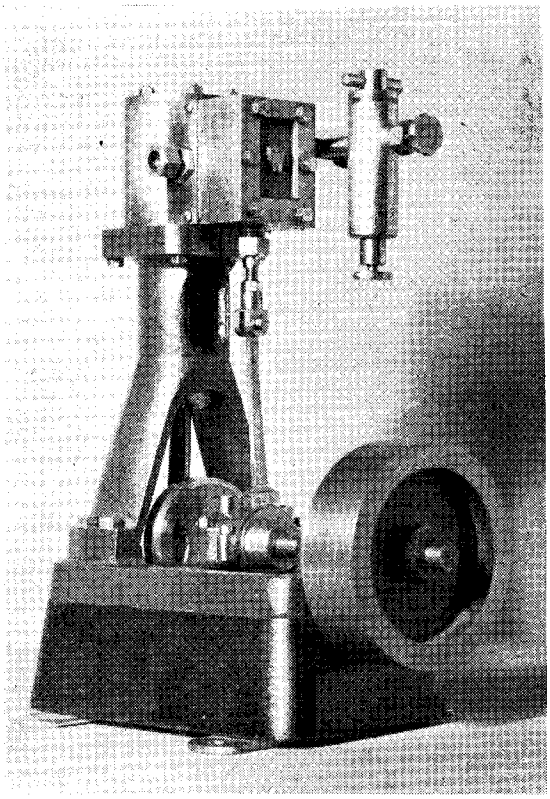
The trunk guide was next bored out to ¾ in. and the end faced off. By slipping the trunk-guide on to a

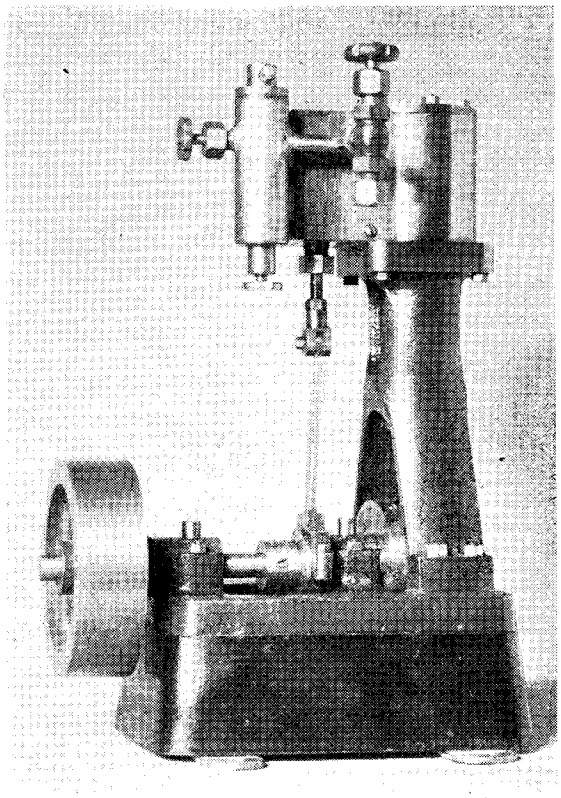


Details of the displacement lubricator



Lubricator and stop-valve





stub-mandrel held in the three-jaw chuck, the bolting faces of the column feet can be trued up by taking light cuts.

If the engine is to be used under steam, some means of cylinder lubrication should be provided, so details of a simple displacement lubricator which has proved highly satisfactory in service are given. The body was turned from $\frac{1}{2}$ in. round brass bar and the steam connections from $\frac{3}{16}$ in. round brass bar. The drawings, I hope, make the construction quite clear. The whole was silver-soldered together with Easy-flo in one go.

A fibre washer is fitted under the oil filler cap to ensure steam-tightness.

The steam stop-valve is of the wheel angle-valve type described many times by " L.B.S.C."

This little engine has done countless hours of running and has been fitted with a wooden base for stationary work.

MUSICAL MECHANISM

(*Continued from page* 386)

the usual period of continuous work being only about half an hour to an hour at a time.

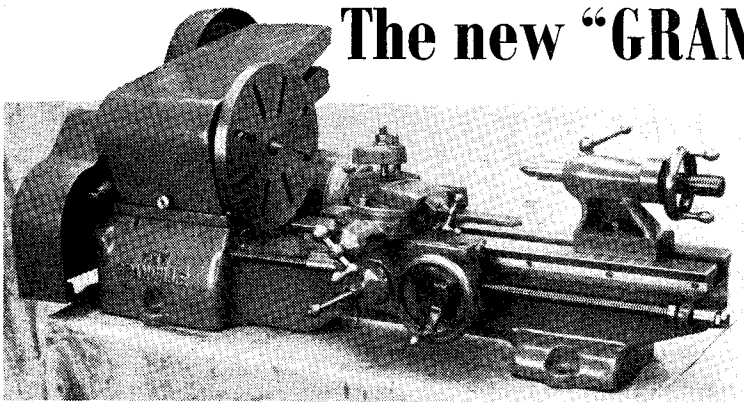
This Polyphon Music Box was made in Leipzig, Germany. Production ceased in 1914.

Were the attractiveness of large music boxes to be better known and understood, a Guild of Music Box Restorers might come into being for the exchange of information and spare parts, because, as remarked earlier, there are plenty of broken ones available. Many of these are well within the scope of skilled model engineers, so far as repairs are concerned. No one succeeding in renovating a " dead " music box and turning it into a beautiful musical instrument could possibly regret the time so expended.

Shortly after completing the above notes, I chanced to be in Farringdon Road, London, with a mind far removed from music boxes. While wandering along, at one of the stalls, my eye rested on a box of junk, some of which I thought I recognised. It proved to be parts of a Polyphon. These included an " endless screw," complete with its c.i. bracket (see Photograph No. 7). I bought the lot. The " endless screw " was polished, burnished and fitted in place of the one I had " carved " out. It ran as soon as it was fitted, without any resetting, which, I think, showed that there was not too much the matter with the said " carving." This exchange was only made because it was thought the steel in the genuine article might be better for its purpose (it has to stand a heavy strain) than the steel in mine.

I am greatly indebted to Mr. J. E. T. Clark, author of " Musical Boxes, A History and an Appreciation," for the amount of information conveyed in his book and for his very kind gift of a female stopwork. I would also like to thank Mr. J. Ramsay for the photographs he supplied, and the trouble he went to in taking them.

The new "GRANVILLE JUNIOR" 3½-in. LATHE



General view of the new "Granville Junior" 3½-in. lathe

THIS recent addition to the range of Granville machine tools has been brought to our notice by Messrs. F. Coals Ltd., Woodford Avenue, Woodford Green, Essex, and we have been given facilities for a close examination and working test of a sample machine at the works. The new production completely supersedes the previous "Junior" 3½-in. lathe, which has been discontinued, and its general appearance and specification are more in conformity with that of the "Senior" 3½-in. lathe which was reviewed in THE MODEL ENGINEER two years ago, but it embodies the experience acquired in the production of both types, and the accent of the design is on sturdiness and rigidity, with the inclusion of all features essential to a machine suitable either for amateur or professional use, compatible with low cost.

The bed of this lathe is of the box girder type, resembling in some respects that of the "Senior" lathe, but a special feature is the increased breadth under the headstock, and it is also shortened to the extent of nearly four inches. It has sliding ways 4 5/16 in. wide, with vee shears, and these form a guide for the sliding saddle, while the central groove guides the tailstock, which is provided with a close-fitting tongue. The alignment of the headstock is also by a similar tongue, and it is held down by two bolts. The mandrel runs in bronze bearings of the half-split type, the front one being of specially large diameter to cope with heavy side-thrust loads, and a ball-race is fitted to take end-thrust. The mandrel nose is 1⅛ in. diameter, screwed 12 t.p.i., and bored right through to admit ⅝ in. diameter, with No. 2 Morse taper socket.

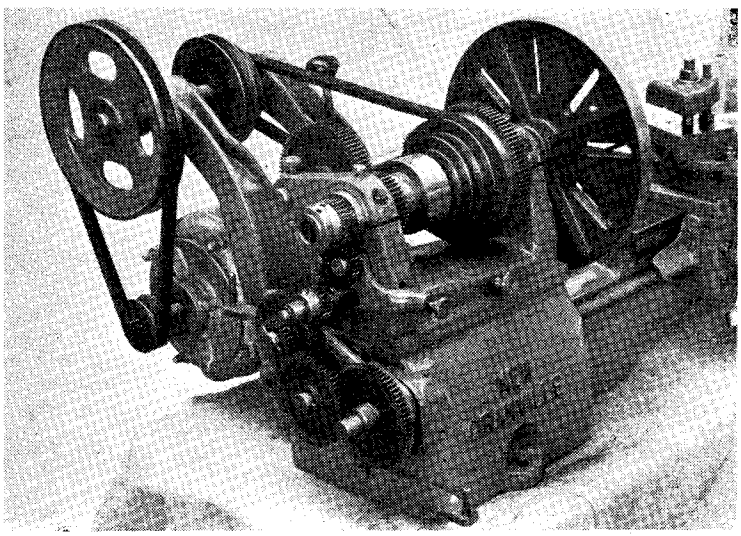
The tailstock barrel is similarly bored, and takes the same size taper fittings; it is 1 in. diameter outside and screwed 8 t.p.i. square thread for the feed handwheel, the maximum travel of the barrel being 3¾ in. Set-over adjustment is provided on the base, and it is positively held down by a bolt and nut.

The saddle has long sliding ways which project on either side of the tailstock to provide maximum bearing area. A long cross-slide, having the tee-slotted boring table which is such a valuable practical feature of English type lathes, is fitted, and the top-slide is held down by the tee-bolts front and back, which engage in quadrant slots in the slide base. The cross-slide feedscrew is ⅜ in. diameter 8 t.p.i., and the top-slide screw of similar diameter, 16 t.p.i., the maximum traverse being respectively 6 in. and 3¾ in.; both feed-screws have ball handles and graduated index dials.

An 8 t.p.i. leadscrew ⅝ in. diameter with Acme thread, is fitted, and engagement with the saddle is by a cam-controlled double-action split nut, working in vertical ways in the apron; the latter also carries the rack feed handwheel, and at the forward end, a swarf guard for the leadscrew.

Countershaft and Motor Unit

This is a compact assembly attached to the back of the lathe headstock, the bearing bracket being hinged to permit easy speed changing, and controlled by a lever-operated cam with adjustment for belt tension. Both primary and secondary drives



A view of the headstock, change gears and countershaft unit, with guards removed

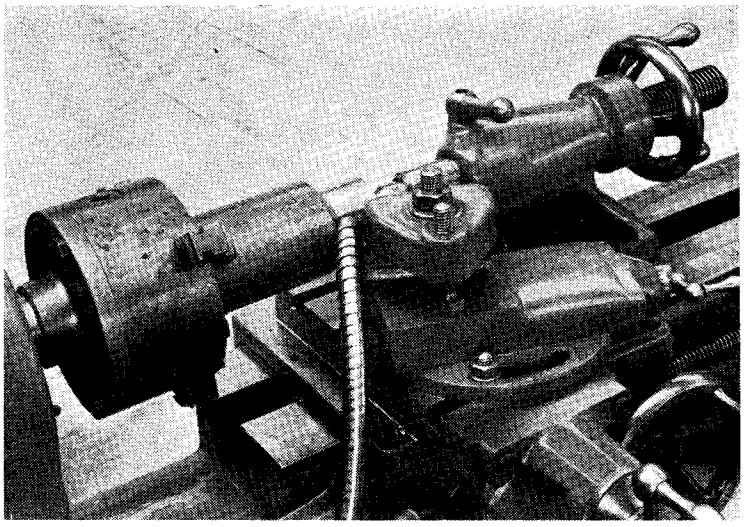
are by vee-belts, (A section), and protection to conform with factory regulations is provided by cast-aluminium guards; the same applies to the change gears. All guards are quickly removable for ready access to the parts.

Eleven change wheels, from 20 to 65 teeth, covering all British standard fractional-inch pitches, and also self-acting feeds up to 176.6 per inch, are provided. The back-gear is of the sliding engagement type, giving a reduction of 6 to 1, and in conjunction with the normal drive pulleys and a motor of 1,420 r.p.m., gives a range of six speeds from 60 to 720 r.p.m. at the mandrel. If desired, the lathe can be supplied without the countershaft and motor unit, and with either flat or vee stepped-pulley on the mandrel.

The essential dimensions of the new Granville Junior lathe are as follows:

Height of centres, 3½ in.; maximum distance between centres, 18 in.; maximum swing in gap, 10 in. diameter; width of gap in front of faceplate, 2¼ in.; swing over cross-slide, 4 in. diameter. Overall length of lathe, including gear guard, 39 in.; overall width, including driving motor, 28 in.; net weight, including countershaft but not motor, 1½ cwt. The standard equipment includes one 9 in. faceplate, one driving plate, one 4 in. chuck adapter, change gears with spacing and driving collars, driving belts, guards, one soft live centre, one stellite-tipped tailstock centre, one 2 in. motor pulley, and screwcutting chart. Extra accessories available include fixed and travelling steadies, plain and swivelling vertical-slides, four-way turret tool-holder, machine vice, leadscrew handwheel, screwcutting indicator, angle plates, etc.

Granville lathes are obtainable from tool dealers advertising in THE MODEL ENGINEER, or direct from the manufacturers at the address given on the previous page.



The "Granville Junior" lathe taking a cut of ¼ in. radial depth in mild-steel

For the BOOKSHELF

Gears for Small Mechanisms. By W. O. Davis. (London: N.A.G. Press Ltd.). Price 25s. (by post 26s.).

This book deals with an aspect of toothed gearing on which there has hitherto been very little data available, namely, the particular problems of its application to small machines such as clocks, watches and instruments. A good deal has been written on the subject of involute gears, as employed almost universally in ordinary engineering practice, but it has been found that such gears are often less efficient in small machines than cycloidal and other forms of gears which have been evolved through long practical experience for their specific purpose.

The opening chapters of the book deal with the theory of gearing in general, and small gears in particular, the friction in toothed gearing, and its mechanical efficiency under various conditions of working, also load carrying capacity. This is followed by four chapters on gear cutting, including hobbing and other generating processes, milling cutters, and methods of finishing gears by polishing, shaving and grinding. Tooth forms for helical, worm, and bevel gears for instruments, merits of various pressure angles, scale effects, and dimensional tolerances, are discussed in detail. The two concluding chapters deal with miscellaneous problems, including planetary gears, the application of plastic materials for gear wheels, and methods of measuring and testing high precision gears.

The author is a practical engineer with a unique experience in the production and application of small gearing, and has undoubtedly made an important contribution to the science of the subject in this book, which may confidently be recommended to anyone seeking advice on the many problems which arise in the production and use of gears.

Strange Travels in Science Fiction. Edited by Geoff Conklin.

The Twenty-Second Century. By John Cristopher. (London: Grayson & Grayson, Ltd.). Price 9s. 6d. each book.

While the subject of science fiction is a little outside the normal scope of this journal, there is no doubt about its increasing popularity, and many of our readers will no doubt be interested in these books. The first is a selection of stories by some of the best-known science-fiction writers, including H. P. Lovecraft, Jack London, Paul Ernst, and Ray Bradbury, while the second is a number of stories by an English author whose work has gained a wide reputation in trans-atlantic science-fiction magazines.

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

TAKING TOOLS TO AUSTRALIA

DEAR SIR,—I read with much interest Mr. F. G. Hobbs's letter which you published in your January, 7th, 1954 issue, and I felt it may be a little misleading to possible migrants to Australia, and have taken the trouble to get the exact position from the Government Department concerned.

If a model engineer has a lathe and other equipment, he may by all means bring it, but on landing he would be required to give assurances that the equipment had been in his possession for 1 year or more, and that it did not exceed £200 in value. He would also be called on to satisfy the Customs Department, that he would not sell it within three years. If satisfactory assurances in these ways were not forthcoming, duty would be 15 per cent., and sales tax 12½ per cent.

There is no scarcity of small lathes suitable for the model engineer in Australia, and to say they are dear may be correct when compared with conditions in England; but the prices of Australian lathes are cheaper when compared with wages earned. A copy of the Southbend "C" Model made in England takes 16 weeks wages (£7 per week) to buy it. An equal Australian-made copy can be bought with 10 weeks wages in Australia.

Mr. Hobbs's letter would also lead one to believe that New South Wales had a monopoly of the engineering industry. This is not so. Engineering is growing rapidly in all states, and roughly in proportion to their populations, and, as a model engineer, I hope this hobby will likewise continue to grow.

Yours faithfully,
Southwark. F. W. HERCUS.
S. Australia.

"OBSOLETE" STEAM ENGINES

DEAR SIR,—I feel that I am only voicing the feelings of many MODEL ENGINEER readers when I say how much I appreciate the recent apparent return of interest in the "obsolete" stationary (and portable) steam engine, and how interested I am in the "Talking About Steam" articles, Mr. Westbury's utility engines, and the recent two, all-too-brief articles by "Student." Can we devotees of the stationary steam plant plead for more of this type of article—whispering low that the locomotive, car and boat boys have had a good run?

Yours faithfully,
Buchnall. "JAYDEE."

MODEL WEIR PUMP

DEAR SIR,—In your December 31st issue there is a picture and statement of Mr. Burville of Eastbourne, who has fitted a Weir pump to a 3½-in. gauge *Baker* locomotive. Could you get him to describe in THE MODEL ENGINEER the details and sizes of the various parts of his very efficient little feed pump. I am sure many other readers beside myself would be interested.

Yours faithfully,
Weymouth. E. A. ISON.

THE CRAMPTON TOUCH

DEAR SIR,—May I congratulate E. W. Twining for his excellent articles on "British Crampton Locomotives" in THE MODEL ENGINEER. He would perhaps be interested to know that my father, although crippled and a diabetic, built, at the age of 75, *Juliet* and *Ajax* from THE MODEL ENGINEER. He is the grandson of T. R. Crampton, and is known in the Eltham Club as "Pop." The craft still lingers. He is rising 77, and still to be found in the workshop. To me he is (forgive the pun) "*in loco parentis*."

Yours faithfully,
Portslade. C. G. CRAMPTON, Jnr.

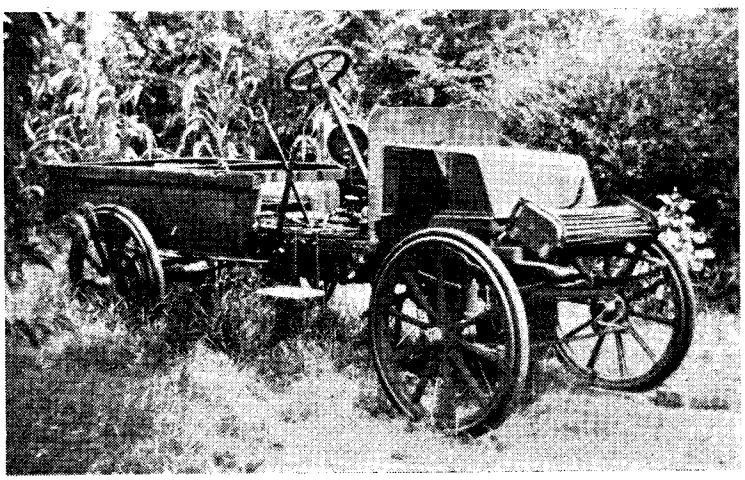
AN OLD STEAM LORRY

DEAR SIR,—The reproduced photograph is of a steam lorry which was recently purchased together with a 1907 Stanley steam car, by Mr. M. Pearman of Greenside, Johannesburg.

The Stanley steam car, which is reputed to have been used by Lord Kitchener, Mr. Pearman intends to rebuild, and has the ambition of driving it to Durban and back at a speed of 60 m.p.h.

The steam lorry is a big puzzle, as no one appears to know its age, country of manufacture and, therefore, firm that manufactured it. The engine is very similar to the Stanely engine in that it has two cylinders and is double-acting. The final drive is by way of a chain. Since we are interested in the origin of the lorry, is it possible that one of your many readers might be able to give us full details of it? There are no marks on the lorry or components that might give a clue to its origin.

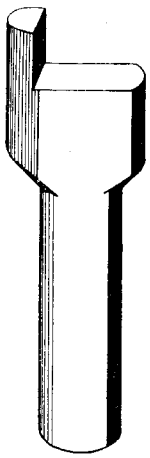
Yours faithfully,
Johannesburg. C. M. W. ROBERTS.



A SIMPLE FILING REST

DEAR SIR,—As an alternative to Mr. K. N. Harris's filing rest for the lathe, as described in the January 21st issue, I give herewith a sketch of mine.

It is a piece of hardwood turned to fit the handrest in place of the "T," the rest itself being swung round to the back of the lathe.



The point of the file rests lightly on the wood for guidance, most of the downward pressure being on the handle, so that the heel of the file does the cutting.

The primary object of a rest is to give a flat surface; this it does. Incidentally, I do not like the idea of file teeth on hardened steel rollers.

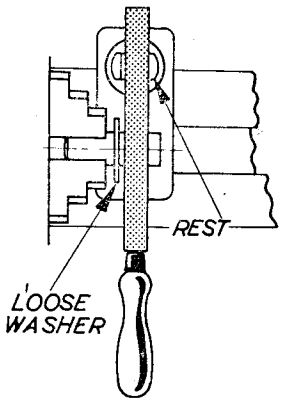
Yours faithfully,
Hengoed. F. READ.

"PRECISION" GROUND STEEL

DEAR SIR,—I was interested in Mr. Burdett's remarks on silver-steel, and have met with exactly the same faults as those about which he complains. Although sold as "precision ground," it invariably has distinct lobes and is not ground to a truly circular form. In addition to this, the ends of the bar are nearly always glass hard, and have to be cut off and discarded, presumably because they are cut with a high speed abrasive disc, making it necessary to quench in order to facilitate subsequent handling.

I suggest that the term "precision ground" is misleading, in that in engineering circles the words immediately bring to mind something well finished to limits measurable only in tenths of thousandths of an inch. I cannot help saying that, as this material carries a very and unnecessarily high price, there is room for considerable improvement; or alternatively, the purchaser should be warned that it is only ground to look pretty and cannot be relied upon to be truly circular, except to within limits of 0.001 in., which, for "precision ground" work, is no credit to the grinding profession.

Yours faithfully,
Sedlescombe. J. B. HUGHES.



HOROLOGICAL TROUBLES

DEAR SIR,—I was interested in the letter from Mr. H. G. Sharpe, headed "Clock Lubrication," in your issue of February 25th, because I recently had the reverse experience.

I have a reasonably good quality wrist watch with a Swiss movement in a water-proof case, which has served me well and reliably for nearly 20 years. Some months ago it suddenly ceased to keep a steady rate. I washed it out in chloroform, as I have done before, without making any improvement, so I thought it was perhaps time it had a professional overhaul and sent it to Clerkenwell to be done. When it came back (with a considerable bill), I was much disappointed to find it little if any more regular than when I sent it away.

At this point a friend suggested that perhaps it had got magnetised. I happened to have by me a coil of about 1,000 turns which would carry 2 amps for a short time; and into which the watch would just go, so I set this up and adjusted the current with one of the most useful things in my workshop—a "Variac" variable voltage transformer. When the watch had been demagnetised by being passed slowly through the coil a few times with the current on, all my troubles disappeared, because the watch kept as good time as ever it did.

How it got magnetised I have no idea, but it does seem to be a thing that happens to watches, even though it was not, I think, Mr. Sharpe's trouble.

Yours faithfully,
Ambleside. H. C. GILSON.

GARRETT TRACTIONS

DEAR SIR,—I wonder if any reader of THE MODEL ENGINEER can assist we with details and dimensions of the Garrett *Suffolk Punch* steam tractor, and the *Best* 110 h.p. logging engines built in the opening years of the century. Unfortunately, my Garrett traction and steam tractor catalogues were the only ones of my collection not to survive the frequent moves of the war years, but I would be glad to exchange other literature in my possession relating to other manufacturers' engines for any Garrett information.

Could not Mr. Clark be pursuaded to continue further his excellent articles on the lesser-known traction-engine makers—I feel that there cannot be enough articles on these fine engines, now, alas, merely a memory, in so many parts of the country.

Yours faithfully,
Tredunnock. JOHN HAINING.

L.B.S.C.'s "TITFIELD THUNDERBOLT"

(*Continued from page* 383)

plug all the holes except two, connect a big pressure gauge to one of them, and an ordinary tender hand pump to the other. Pump water into the boiler by stages, until the gauge shows twice the working pressure, say 150 lb. examining for leakage or bulging as you go along. Take no notice of a slight movement, which is merely the soft copper settling itself to resist strain. The big hole on top of the haystack dome, can be covered by a temporary plate clamped in place, with a rubber gasket (bit of an old car tyre tube) between plate and flange. As I've often stressed in these notes, there is no need to test to excessive pressure, which only puts undue strain on the plates and joints; boilers built to my specifications *have* been tested to excessive pressures, but they were exceptional cases, just to prove that the boilers had a very great margin of safety. Next stages, smokeboxes and fittings.